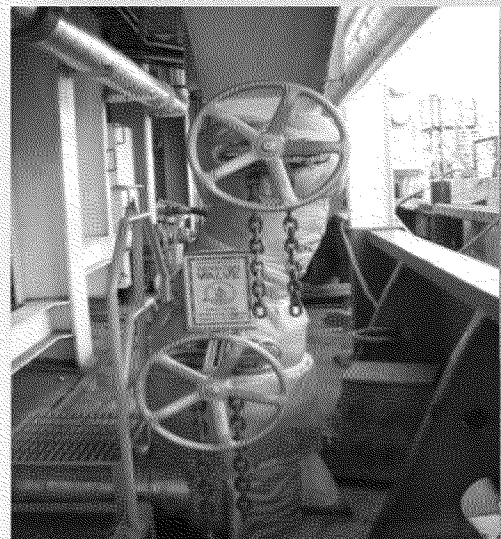
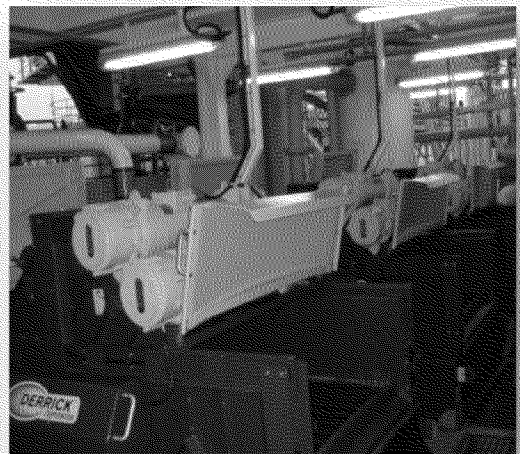

Quality Assurance Project Plan for Exploration Drilling in Alaska Outer Continental Shelf, Chukchi Sea, On the Motor Vessel Noble Discoverer



Effective: May 2013

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Table of Contents

1.0	PROJECT MANAGEMENT	1
1.1	PURPOSE AND SCOPE	1
1.2	PROJECT DEFINITION/BACKGROUND.....	1
1.3	PROJECT TASK DESCRIPTION	2
1.4	PROJECT QUALITY OBJECTIVES	3
1.4.1	Data Quality Objectives.....	3
1.4.2	Data Quality Indicators.....	3
1.5	SPECIAL TRAINING AND CERTIFICATIONS.....	6
1.5.1	Health, Safety, and Environment Program Training	6
1.5.2	General Permit Training Curriculum for Operational Discharge Compliance Specialists	7
1.5.3	Operational Discharge Compliance Specialist Demonstration of Capability.....	7
1.6	DOCUMENTS AND RECORDS.....	7
1.6.1	Document Revisions.....	8
1.6.2	Field and Onsite Laboratory Documentation	8
1.6.3	Archival, Maintenance, and Retention of Project Files	9
1.6.4	Confidentiality and Proprietary Rights.....	9
1.7	SAMPLE HANDLING, DOCUMENTATION, AND CHAIN-OF-CUSTODY PROCEDURES	9
1.7.1	Sample Containers and Preservation	10
1.7.2	Sample Storage	10
1.7.3	Sample Retention and Disposal	10
1.7.4	Sample Labeling	10
1.7.5	Chain-of-Custody Procedures	11
1.7.6	Packaging and Shipment of Samples	12
1.8	FIELD AND LABORATORY QC SAMPLES	13
1.8.1	Field QC Samples	13
1.8.2	Laboratory QC Samples	14
1.9	PROJECT ASSESSMENT AND OVERSIGHT.....	16
1.9.1	Project Audits/Assessments.....	16
1.9.2	Audit Reporting	16
1.9.3	Corrective Action.....	16
2.0	COMPLIANCE SAMPLING PROGRAM FOR OPERATIONAL DISCHARGES	19
2.1	INTRODUCTION AND OVERVIEW.....	19
2.2	OPERATIONAL DISCHARGE COMPLIANCE PROGRAM ROLES AND RESPONSIBILITIES.....	29
2.2.1	Operations Manager/Drilling Superintendent	29
2.2.2	Wells HSE Department	29
2.2.3	Shell Regulatory Affairs Compliance Engineer	29
2.2.4	M-I SWACO Compliance Supervisor	30
2.2.5	M-I SWACO Compliance Specialist	30
2.2.6	Project Organization Chart	31
2.3	DATA QUALITY OBJECTIVES.....	32
2.4	FIELD SAMPLING	32
2.4.1	Sampling, Measurement, and Observation Locations	32
2.4.2	Sampling, Measurement, and Observation Frequencies.....	35
2.4.3	Compliance Sampling Requirements for Each Operational Discharge	36
2.4.4	Field SOPs	58
2.4.5	Analytical SOPs	60
2.4.6	Sample Handling and Custody	61
2.4.7	Field Instrument/Equipment Testing, Inspection, Calibration, and Maintenance	64
2.4.8	Subcontract Laboratory Instrument/Equipment Testing, Inspection, Calibration, and Maintenance	69
2.5	LABORATORY ANALYSIS	70
2.5.1	Analytical Laboratory Methods.....	72
2.6	FIELD AND LABORATORY QUALITY CONTROL SAMPLES.....	74
2.6.1	Field Quality Control Samples and Frequencies.....	74
2.6.2	Laboratory Quality Control	77
2.7	DOCUMENTS AND RECORDS.....	81

2.7.1	Responsibilities.....	81
2.7.2	Field and Laboratory Records	81
2.8	REPORTING.....	86
2.8.1	Notifications.....	86
2.8.2	Discharge Monitoring Reports	86
2.8.3	TAH/TAqH Reporting	86
2.9	DATA REPORTING.....	87
2.10	DATA REVIEW AND QUALIFICATION	88
2.10.1	Laboratory Data Evaluation.....	88
2.10.2	Data Review and Verification	88
3.0	ENVIRONMENTAL MONITORING PROGRAM	91
3.1	INTRODUCTION AND OVERVIEW.....	91
3.2	EMP ROLES AND RESPONSIBILITIES	91
3.2.1	Project Organization	94
3.3	DATA QUALITY OBJECTIVES.....	97
3.4	SAMPLING DESIGN: PHASE I THROUGH IV	98
3.4.1	Phase I Assessments	98
3.4.2	Phase II Plume Monitoring and Observations	103
3.4.3	Phase III Assessment.....	105
3.4.4	Phase IV Assessment.....	107
3.5	FIELD SAMPLING	107
3.5.1	Sampling Methods	107
3.5.2	Sample Handling and Custody	118
3.5.3	Field Instrument/Equipment Calibration, Maintenance, and Operation	121
3.6	LABORATORY ANALYSIS	121
3.6.1	Analytical Methods.....	121
3.6.2	Samples for Metals Analysis	124
3.6.3	Samples for Hydrocarbon Analysis (Phases II, III, and IV)	129
3.6.4	Macrofaunal Analysis.....	139
3.6.5	Sediment Profile Imagery Analysis	140
3.6.6	Instrument/Equipment Calibration, Maintenance, and Operation	143
3.7	QUALITY ASSURANCE/QUALITY CONTROL	147
3.7.1	Field Quality Control.....	148
3.7.2	Laboratory Quality Control	151
3.7.3	Standard Reference Material	155
3.8	NONDIRECT MEASUREMENTS	156
3.9	DATA MANAGEMENT	156
3.9.1	Document Control	156
3.9.2	Data Storage Requirements	157
3.9.3	Documentation Standards.....	158
3.9.4	Hardware and Software Requirements	158
3.9.5	Changes and Deviations	159
3.9.6	Data Reporting	159
3.9.7	Data Reduction	160
3.10	DATA REVIEW/QUALIFICATION	161
4.0	REFERENCES	163

Tables

Title	Page
Chukchi Sea AKG-28-8100 QAPP Revision Summary Table	R-1
Table 1-1 Geographical Drill Site Locations	2
Table 2-1 Effluent Limitations and Monitoring Requirements for Water-Based Drilling Fluids/Drill Cuttings (Discharge 001)	21
Table 2-2 Discharge Rate Limitations and Monitoring Frequency for Water-Based Drilling Fluids and Drill Cuttings (Discharge 001)	23
Table 2-3 Effluent Limitations and Monitoring Requirements for Deck Drainage (Discharge 002)	24
Table 2-4 Effluent Limitations and Monitoring Requirements for Sanitary and Domestic Wastes (Discharges 003 and 004)	25
Table 2-5 Effluent Limitations and Monitoring Requirements for Miscellaneous Discharges	26
Table 2-6 Discharge Sampling Locations	33
Table 2-7 Summary of Compliance Sampling, Measurement, and Observation Frequencies and Related SOPs.....	36
Table 2-8 Effluent Sample Holding Times for Toxicity Testing	38
Table 2-9 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 001	41
Table 2-10 Analytical Sampling for Water-Based Drilling Fluids and Drill Cuttings (Discharge 001) .	42
Table 2-11 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 002	44
Table 2-12 Analytical Sampling for Deck Drainage (Discharge 002)	45
Table 2-13 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 003	47
Table 2-14 Analytical Sampling for Sanitary Wastes (Discharge 003)	48
Table 2-15 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 004	49
Table 2-16 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 005	50
Table 2-17 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 006	51
Table 2-18 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 007	52
Table 2-19 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 008	54
Table 2-20 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 009	55
Table 2-21 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 010	56
Table 2-22 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 011	57
Table 2-23 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 012	58
Table 2-24 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 013	58

AKG-28-8100–Noble Discoverer Revision 0, Effective Date May 2013	Page i of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Table 2-25	Operational Discharge Compliance Sampling Related SOPs	60
Table 2-26	Drilling Fluid and Effluent Toxicity Testing SOPs	61
Table 2-27	Sample Containers, Preservation, and Holding Times	62
Table 2-28	Onsite Laboratory Equipment Calibration	67
Table 2-29	Analytical Subcontract Laboratories	71
Table 2-30	Drilling Fluid and Effluent Toxicity Testing Methods	72
Table 2-31	Analytical Laboratory Reporting Limits	73
Table 2-32	Field Quality Control Samples	75
Table 2-33	Analytical Method Quality Control Criteria	77
Table 2-34	Water Quality Criteria and Performance Standards	79
Table 2-35	Toxicity Test Acceptance Criteria and Performance Standards	80
Table 2-36	General Permit Compliance Records by Location	83
Table 2-37	Service Quality Non-Conformance Report	85
Table 3-1	Roles and Responsibilities of the EMP Implementation Team	93
Table 3-2	Summary of Field Sampling for the Four Monitoring Phases	97
Table 3-3	Summary of Analytical Parameters by Matrix	99
Table 3-4	Number of Samples Slated for Collection During Phase II	105
Table 3-5	Summary of Near-Field ¹ Phase III and IV Samples Slated for Collection	107
Table 3-6	Sample Containers, Sample Sizes, Preservative Requirements, and Holding Times	113
Table 3-7	Sample Identification Scheme	118
Table 3-8	Field Equipment Calibration, Maintenance, Testing, and Inspection	122
Table 3-9	Laboratory Analytical Methods	123
Table 3-10	Metals and Analytical Instruments for Each Phase of Environmental Monitoring with Laboratory Limits	127
Table 3-11	List of Polycyclic Aromatic Hydrocarbon and Alkyl PAH Target Analytes with Reporting Limits and Method Detection Limits	131
Table 3-12	List of Saturated Hydrocarbons Target Analytes with Reporting Limits and Method Detection Limits	133
Table 3-13	List of Volatile Organic Carbon Target Analytes with Reporting Limits and Method Detection Limits	135
Table 3-14	List of Petroleum Biomarker (St/Tr) Target Analytes with Reporting Limits and Method Detection Limits	137
Table 3-15	Sediment Profile Imagery Parameters	140
Table 3-16	Calibration Procedures for Laboratory Instruments	145
Table 3-17	Standard Operating Procedures	147
Table 3-18	Typical Accuracy and Precision of Instrument Sensors (ADCP and OBS)	151
Table 3-19	Typical Accuracy and Precision of Instrument Sensors (CTD)	151
Table 3-20	Measurement Quality Criteria	152
Table 3-21	Analytical Data Qualifiers	162

Figures

Title	Page
Figure 2-1 Organizational Structure for the Operational Discharge Compliance Program	31
Figure 3-1 Organizational Structure for the Environmental Monitoring Plan Implementation Team	95
Figure 3-2 Phase II Water Sampling Stations	104
Figure 3-3 Phase III and IV Sampling Stations	106
Figure 3-4 Rosette Water Sampler with Go-Flow Bottles and CTD Sensors.....	110
Figure 3-5 Sediment Profile Imaging and Plan View Camera Systems	116
Figure 3-6 Example Sample Label	119

AKG-28-8100–Noble Discoverer Revision 0, Effective Date May 2013	Page i of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Acronyms List

°C	degrees Celsius
°F	degrees Fahrenheit
ADCP	acoustic doppler current profilers
Ag	silver
Al	aluminum
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
ANOVA	analysis of variance
As	arsenic
Ba	barium
bbl/h	barrel(s) per hour
Be	beryllium
BI	benthic infauna (sample identification code)
BOD ₅	5-day biochemical oxygen demand
CA	SPI computer analysis
CAB	Chemistry and Benthos
cANIMIDA	continuation Arctic Nearshore Impact Monitoring in Development Area
CC	Drilling cuttings chemistry (sample identification code)
CCA	canonical correspondence analysis
CCV	continuing calibration verification
Cd	cadmium
CFR	Code of Federal Regulations
cm	centimeter
CoC	chain-of-custody
COMIDA	Chukchi Sea Offshore Monitoring in Drilling Area
Cr	chromium
CRM	certified reference material
CSESP	Chukchi Sea Environmental Studies Program
CTD	conductivity, temperature, depth (profiler)
Cu	copper
CVAAS	cold vapor atomic absorption spectrometry
CVAF	cold vapor atomic fluorescence
DC	drilling fluid chemistry (sample identification code)
DCM	dichloromethane
DDW	distilled deionized water

AKG-28-8100–Noble Discoverer Revision 0, Effective Date May 2013	Page ii of 174
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Acronyms List (Continued)

DL	detection limit
DMR	Discharge Monitoring Report
DOC	demonstration of capability
DOT	U.S. Department of Transportation
DQI	data quality indicator
DQO	data quality objective
DU	duplicate
EB	equipment blank
EDD	electronic data deliverable
EMP	environmental monitoring program
EPA	(U.S.) Environmental Protection Agency
FAAS	Flame Atomic Absorption Spectrophotometry
FB	field blank
FC	fecal coliform
Fe	iron
FIT	Florida Institute of Technology
FWS	Fairweather Science
g	grams
gal	gallons
GC	gas chromatograph
GC/FID	gas chromatography/flame-ionization detection
GC/MS	gas chromatography/mass spectrometry
GFAAS	graphite furnace atomic absorption spectrometry
GPS	global positioning system
H ₂ O ₂	hydrogen peroxide
H ₂ SO ₄	sulfuric acid
HCl	hydrochloric acid
HClO ₄	perchloric acid
HF	hydrofluoric acid
Hg	mercury
HMIS	Hazardous Materials Identification System
HNO ₃	nitric acid
HPLC	high performance liquid chromatography

AKG-28-8100–Noble Discoverer Revision 0, Effective Date May 2013	Page iii of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Acronyms List (Continued)

HSE	Health, Safety, and Environment
IATA	International Air Transport Association
ICAL	initial calibration
ICC	independent calibration check
ICP-MS	inductively coupled plasma/mass spectrometry
ID	identification
IS	internal standards
ISO	International Organization for Standardization
LC	water (liquid) chemistry (sample identification code)
LCL	lower control limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOD	limit of detection
LOQ	limit of quantitation
LWI	local work instruction
m	meter(s)
MB	method blank
MDL	method detection limit
MeHg	methyl mercury
mg	milligram
mgd	million gallons per day
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
µg/L	microgram(s) per liter
M-I SWACO	M-I SWACO, contractor to Shell
mL	milliliter(s)
MLLW	mean lower low water
MQO	measurement quality objectives
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
M/V	motor vessel

AKG-28-8100–Noble Discoverer Revision 0, Effective Date May 2013	Page iv of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Acronyms List (Continued)

NA	not available
NAD	North American Datum
Na ₂ S ₂ O ₃	sodium thiosulfate
nMDS	non-metric multidimensional scaling
NMFS	National Marine Fisheries Service
Ni	nickel
NIST	National Institute of Standards and Technology
<i>Noble Discoverer</i>	M/V Noble Discoverer
NPDES	National Pollutant Discharge Elimination System
NS	not spiked
NSC	North Slope Crude
OBS	optical backscatter turbidity sensor
OCS	Outer Continental Shelf
OPR	ongoing precision and recovery
OSI	organism sediment index
PAH	polycyclic aromatic hydrocarbons
PARCCS	precision, accuracy, comparability, completeness, sensitivity
Pb	lead
PCA	principal component analysis
PD	percent difference
PM	project manager
ppm	parts per million
POC	particulate organic carbon
PV	sediment profile imagery plan view photograph (sample identification code)
QA	quality assurance
QADU	laboratory duplicates
QAM	quality assurance manager
QAPP	quality assurance project plan
QC	quality control
RL	reporting limit
ROV	remotely operated vehicle
RPD	relative percent difference
RSD	relative standard deviation

AKG-28-8100–Noble Discoverer Revision 0, Effective Date May 2013	Page v of 174
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Acronyms List (Continued)

SAV	submerged aquatic vegetation
Sb	antimony
SC	sediment chemistry (sample identification code)
SDG	sample delivery group
Se	selenium
SHC	saturated hydrocarbons
Shell	Shell Gulf of Mexico, Inc.
SIM	selected ion-monitoring
SIS	surrogate internal standard
Sn	tin
SOP	standard operating procedure
SP	Sediment Profile Imagery photograph (sample identification code)
SPI	sediment profile imaging
SPI RPD	redox potential discontinuity (for SPI analysis)
SPP	suspended particulate phase
SRM	standard reference material
St/Tr	sterane/triterpanes
s.u.	standard units
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TB	trip blank
TBD	to be determined
TEM	total extractable material
Ti	titanium
Tl	thallium
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TSS	total suspended solids
TU _c	chronic toxic units
UCL	upper control limit
U.S.	United States
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency

AKG-28-8100–Noble Discoverer Revision 0, Effective Date May 2013	Page vi of 174
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Acronyms List (Continued)

V	SPI visual analysis
VOC	volatile organic compound
WBM	water based mud
WC	worm chemistry (sample identification code)
WET	whole effluent toxicity (testing)
ZGFAAS	Zeeman or Continuum background correction
Zn	zinc

AKG-28-8100–Noble Discoverer Revision 0, Effective Date May 2013	Page vii of 174
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Chukchi Sea AKG-28-8100 QAPP Revision Summary Table

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<p align="center">AKG-28-8100– <i>Noble Discoverer</i></p> <p align="center">Revision 0, Effective Date May 2013</p>	<p>Page R-1 of 174</p>
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page R-2 of 174
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1.0 Project Management

1.1 Purpose and Scope

This section identifies Shell Gulf of Mexico, Inc. (Shell) as the operator for the Chukchi Sea Exploration Program and holder of the AKG-28-8100 National Pollutant Discharge Elimination System (NPDES) General Permit (New and Existing Sources and New Dischargers in the Offshore Subcategory of the Oil and Gas Extraction Category) (herein referred to as the General Permit) for wastewater discharges into Arctic Ocean Outer Continental Shelf (OCS) waters.

This Quality Assurance Project Plan (QAPP) defines policies and systems governing the assessment and quality control of sampling, data collection, and laboratory analyses performed to document compliance with the General Permit. This QAPP will be used to assist in sampling and analysis required to support compliance with effluent limitations and monitoring requirements for operational discharges as well as planning for the collection and analysis of data required in the Environmental Monitoring Program (EMP) specified in the General Permit.

Development of the QAPP for work performed under the NPDES General Permit was based upon applicable guidelines and regulatory documents including:

- NPDES General Permit;
- Title 40 of the Code of Federal Regulations, Part 435 (40 CFR Part 435);
- 40 CFR Part 136; and
- U.S. Environmental Protection Agency (USEPA) regulations and guidance, including Requirements for Quality Assurance Project Plans (EPA/QA/R-5) (USEPA 2001) and Guidance for Quality Assurance Project Plans (EPA/QA/G-5) (USEPA 2002).

1.2 Project Definition/Background

In order to fulfill the requirements of the General Permit, field measurements and environmental samples will be collected as part of investigations and characterizations required under the EMP and also to demonstrate compliance with effluent limitations and monitoring requirements specified for operational discharges.

This QAPP has been prepared to satisfy the requirements of Section IV.A. of the General Permit. This QAPP defines the quality assurance (QA) and quality control (QC) procedures that will be followed to ensure that the quality of data obtained from field and laboratory analyses is of known and acceptable quality to achieve project data quality objectives. The QC procedures outlined herein are intended to support the activities requiring the collection of data as described in the EMP Plan of Study, the Best Management Practices (BMP) Plan, standard operating procedures (SOPs), local work instructions (LWIs), job safety assessments (JSAs), and this QAPP. This QAPP provides specific guidance regarding sample collection and handling procedures, referencing the Appendices to the BMP, SOPs, and LWIs, as appropriate.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 1 of 174
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General information about the drillship, support vessels, and exploratory well locations can be found in Section 3 of the BMP. Additional information about the Chukchi Sea site description can be found in the EMP Plan of Study.

1.3 Project Task Description

Shell has contracted Noble Drilling Holding, LLC (Noble Drilling), the owner of the drillship, M/V (Motor Vessel) Noble Discoverer (*Noble Discoverer*), for operations of the vessel during transit and while exploration activities are being conducted. The *Noble Discoverer* is a true offshore oil and gas drillship adapted for operation under Arctic conditions. The *Noble Discoverer* has all necessary drilling equipment and ancillary facilities to explore and complete exploratory wells in the Chukchi Sea.

Shell plans to drill six exploratory wells in the Burger Prospect of the Chukchi Sea. Each of the six possible drill sites will be permitted for drilling to allow for operational flexibility in the event sea ice conditions prevent access to one or more locations. The prospect location is depicted in Figure 3-1 of the BMP. Table 1-1 presents geographical drill site locations for each well in the drilling program.

Table 1-1 Geographical Drill Site Locations

Wells Covered by BMP Plan	Area	Lease Block (Surface)	Surface Locations (NAD 83) ¹		OCS-Y Number
			Latitude (N)	Longitude (W)	
Burger A	Posey	6764	N71°18'30.92"	W163°12'43.17"	OCS-Y-2280
Burger F	Posey	6714	N71°20'13.96"	W163°12'21.75"	OCS-Y-2267
Burger J	Posey	6912	N71°10'24.03"	W163°28'18.52"	OCS-Y-2321
Burger R	Posey	6812	N71°16'06.57"	W163°30'39.44"	OCS-Y-2294
Burger S	Posey	6762	N71°19'25.79"	W163°28'40.84"	OCS-Y-2278
Burger V	Posey	6915	N71°10'33.39"	W163°04'21.23"	OCS-Y-2324

Note:

¹ North American Datum 1983.

Shell Regulatory Affairs has requested authorization for a number of discharges during drilling operations that are regulated by the EPA under the NPDES General Permit and by 40 CFR Part 435. Data collection to verify compliance with the effluent limitations and monitoring requirements of the General Permit will include, but is not limited to, visual assessment of surface conditions of the sea; discharge flow-rate and volume measurements; and collection of samples for field and analytical laboratory analysis. Operational discharge compliance monitoring activities and QA/QC procedures are defined in Section 2 of this QAPP.

In addition to operational discharge compliance monitoring activities, environmental samples will be collected as part of assessments and characterizations required by the EMP. Data collection activities and QA/QC procedures related to the EMP are described in Section 3 of this QAPP.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 2 of 174
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1.4 Project Quality Objectives

The overarching project objectives for Shell's exploration drilling program in the Chukchi Sea are to monitor effluent discharges, implement the EMP Plan of Study, and ensure the collection of data that are of sufficient type, quantity, and quality to meet the regulatory requirements specified by the General Permit.

1.4.1 Data Quality Objectives

The overall data quality objectives (DQOs) for the discharge monitoring program are to ensure that data generated for compliance with the General Permit are scientifically valid, are legally defensible, and support project objectives.

The DQOs for the monitoring of operational discharges, details regarding the sampling design, QA/QC procedures, and data collection for operational discharge compliance sampling can be found in Section 2 of this QAPP.

The DQOs for the EMP, details regarding the sampling design, QA/QC procedures, and data collection for the EMP can be found in Section 3 of this QAPP.

1.4.2 Data Quality Indicators

The quality of the data to be collected for this project will be verified through appropriate criteria established for both sampling procedures and analytical methods. The criteria should relate to data quality indicators (DQIs) consisting of precision, accuracy, representativeness, comparability, completeness, and sensitivity (commonly referred to as PARCCS) parameters. The quality of the sampling procedures and laboratory results will be evaluated for compliance with project DQOs through a review of these parameters. Project DQOs will be considered met when the quality of the data meet precision, accuracy, representativeness, completeness, comparability, and sensitivity requirements specified in this QAPP.

Analytical DQOs will be evaluated by reviewing the QC parameters described in the following sections. Laboratory and field quality control samples are described in more detail in Section 1.10. DQIs that relate specifically to analyses required for the monitoring of operational discharges are included in Section 2. DQIs that relate specifically to analyses required for the EMP are included in Section 3.

1.4.2.1 Precision

Precision measures the reproducibility of measurements. Analytical precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. Precision will be evaluated by comparing the following:

- Laboratory control sample (LCS) and LCS duplicate (LCSD) (if prepared and analyzed) to determine the precision of the laboratory procedures and verify matrix interference;
- Matrix spike (MS) and matrix spike duplicate (MSD) samples to determine the effect of the sample matrix on the precision of the results generated using the selected analytical method;
- Primary and field duplicate sample results;
- Analysis of standard reference material (SRM); and/or
- Laboratory replicate analyses.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 3 of 174
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The LCS determines the precision of the analytical method. If the recoveries of the analytes in the LCS are within established control limits, then precision is within acceptable limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch; rather, the comparison is between a given sample and those samples analyzed in previous batches. If an LCSD is prepared for the batch, the precision of the analysis can be evaluated for the batch.

Precision of two similar values is evaluated by calculating relative percent difference (RPD) using the following equation:

$$RPD = \frac{2|(D_1 - D_2)|}{D_1 + D_2} \times 100$$

Where: D_1 = first sample value
 D_2 = second sample value (replicate)
 RPD = relative percent difference

Percent difference (PD) is a measurement of precision as an indication of how a measured value is different from a “real” value. It is used when one value is known or certified, and the other is measured. The formula for calculated PD is as follows:

$$\text{Percent Difference} = \frac{X_2 - X_1}{X_1} \times 100$$

Where: X_1 = known value (e.g., SRM certified value)
 X_2 = determined value (e.g., SRM concentration determined by analyst)

If two or more aliquots of the same sample are prepared and analyzed by the laboratory, then these are referred to as laboratory replicates. Precision of replicate samples is evaluated by calculating the RSD using the following equation:

$$\%RSD = \frac{\sqrt{\frac{\sum_{i=1}^{i=n} (D_i - \bar{D})^2}{n}}}{\bar{D}} \times 100$$

Where:
 • D_i the individual sample concentrations
 • \bar{D} the mean of n values
 n = the total number of values

Note: Report the absolute value of the result. The RSD is always positive.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 4 of 174
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1.4.2.2 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error (variability that can be assigned to a specific component of the measurement process). Random errors and systematic errors reflect the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard.

Percent recovery is a measurement of accuracy, where one value is compared with a known/certified value. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS or a MS sample to a control limit. Analysis of SRM may also be used to evaluate accuracy.

The formula for calculating percent recovery is as follows:

$$\text{Percent Recovery} = \frac{\text{amount detected}}{\text{amount expected}} \times 100$$

1.4.2.3 Representativeness

Representativeness is a qualitative term that refers to the degree by which the data accurately and precisely depict the characteristics of a population, whether referring to the distribution of a contaminant within a sample, a sample within a matrix, or a contaminant at a site. Representativeness is the qualitative term evaluated to determine that measurements are made and physical samples collected at locations and in a manner that result in proper characterization of a matrix or media. Subsequently, representativeness ensures that a sampled population represents the target population and an aliquot represents a sampling unit.

Assessment of representativeness shall be achieved through use of the standard field, sampling, and analytical procedures. Representativeness will be evaluated by reviewing the following:

- Sample quantities and locations;
- Sampling procedures and equipment;
- Sample CoC forms, laboratory report forms, and laboratory records; and
- Holding times and preservation.

1.4.2.4 Comparability

Comparability addresses the degree to which different methods or data agree or can be represented as similar. The objective for this QA/QC program is to produce data with the greatest possible degree of comparability. Comparability is achieved by the following:

- Using standard methods for sampling and analysis;
- Reporting data in standard units;
- Normalizing results to standard conditions;

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 5 of 174
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- Operating instruments within their calibrated range according to established procedures based on approved methodology; and
- Using standard and comprehensive reporting formats.

1.4.2.5 Completeness

Completeness is calculated for the aggregate data for each analyte measured during any particular sampling event. Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are defined as all results not rejected through data validation.

The following formula is used to calculate completeness:

$$\% \text{ completeness} = \frac{\text{number of valid results for samples analyzed}}{\text{number of possible results for all samples}}$$

1.4.2.6 Sensitivity

Sensitivity is the ability of a method or instrument to detect the target analytes at the level of interest. Analytical methods are selected that will provide results with the sensitivity to meet the project DQOs. The laboratory detection limits and reporting limits will be evaluated against the permit limits in order to determine whether the analytical methods and/or laboratory meet the project DQOs.

1.5 Special Training and Certifications

An overview of the training programs provided by Shell and Shell's contractors for personnel involved in the exploration program is included in Section 12 of the BMP. Each contractor has specific corporate policies, training manuals/programs, safety & environmental risk assessments, and compliance tracking systems as it applies to all oil and gas exploration operations. These documents are available upon request.

Depending on the employee's position and responsibilities, the following training may be required: health and safety training, technical training, general permit training, analytical training, and legal/ethical training. Shell's contractors may provide additional training manuals and information for their respective employees' use. Training records are maintained in accordance with Section 12.2 of the BMP.

The validity of collected data depends, in part, on the qualifications and training of the personnel involved with sampling and analysis. Specialized training or certifications required to complete project tasks related to sampling and analysis are included in the following sections.

1.5.1 Health, Safety, and Environment Program Training

Shell and its contractors have implemented health, safety, and environmental compliance programs that direct all aspects of the operation of the *Noble Discoverer* and employees who are assigned to the ship. All assigned employees are provided regular training on these measures and programs. Aboard the ship, management of all health, safety, and environmental compliance programs are implemented by Shell and its contractors. The detailed plans may be available for review aboard the *Noble Discoverer* if requested.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 6 of 174
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Shell and its drilling contractors will have full time Health, Safety, and Environment (HSE) staff on board during operational periods.

1.5.2 General Permit Training Curriculum for Operational Discharge Compliance Specialists

Operational Discharge Compliance Specialists are responsible for maintaining copies of their training records and notifying Operations Managers/Drilling Superintendents of due dates for refresher training. Specific training requirements related to operational discharges and monitoring activities are specified in the SOPs, which are incorporated by reference into the BMP and in Appendix A of this QAPP.

Each Compliance Specialist shall participate in a regulatory training curriculum prior to providing General Permit compliance data. The curriculum includes presentations and written tests on the following elements:

- Regulatory requirements
- QAPPs
- Documentation procedures
- Applicable SOPs and LWIs

Upon completion of the training curriculum, each trainee and trainer shall complete the appropriate Compliance Specialist Training Documentation Form (M-I SWACO Form 2009-1, Appendix A). This form documents the employee's training on the QAPP, SOPs, specific equipment, analytical techniques, and QC requirements. Compliance Specialist training must be complete and the Compliance Specialist Training Documentation Form complete prior to performing General Permit compliance duties. The Operations Manager/Drilling Superintendent maintains the original forms in the employee training records and the employee maintains a copy within the Compliance Specialist notebook.

1.5.3 Operational Discharge Compliance Specialist Demonstration of Capability

Technicians and analysts who perform measurements, analyses, or evaluations, or who operate instruments or equipment shall have demonstrated proficiency for the specific procedures for which there is a mandatory demonstration of capability (DOC) requirement in the SOP. Demonstration of capability shall be performed each time there is a change in instrument type, personnel, or test method. Procedures for performing and documenting the demonstration of capability are discussed in SOP 1008 Demonstration of Capability (Appendix A). The Demonstration of Capability Certification Statement included in this SOP shall be completed for each analyst, matrix, and method after successful completion of the proficiency testing. One certificate may be used for multi-analyte methods.

1.6 Documents and Records

The quantity of supporting documentation required to conduct environmental analyses necessitates the establishment of a formal system for generating, checking, inventorying, and archiving documents. This section describes document control and recordkeeping as it applies to field and laboratory data generated to demonstrate compliance with the QAPP.

During the Chukchi Sea exploration drilling program, both hard copy and electronic records will be generated by numerous organizations involved in various aspects of the program. Each contractor to Shell

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 7 of 174
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is responsible for ensuring that the records generated by their field staff and/or subcontractors are in compliance with the requirements of this QAPP. All organizations will maintain original records in the specific locations required by their respective QA programs, and copies of their records will be provided as required during and following execution of the project. In general, documentation and recordkeeping will be conducted in accordance with Section 11 of the BMP.

Field and onsite laboratory records are discussed in following sections. The QA program of subcontract laboratories governs their document control. Maintenance, revision, approval, distribution, archival, and retention of records will be in accordance with the subcontract laboratory QA program.

1.6.1 Document Revisions

The QAPP and associated SOPs and LWIs are controlled documents. Each time a revision is made to this manual, it shall be reviewed, documented, and approved. Whenever revisions are made, or addenda added to the QAPP, a document control system shall be initiated to confirm that all parties holding a controlled copy of the QAPP receive the revisions/addenda, and that outdated material is removed from circulation. Employees holding controlled copies of the QAPP will provide certifications that they have read, understood, and updated their copies of the QAPP.

The following procedures will be implemented to ensure that project personnel have the current versions of these documents:

- The document includes a version number and effective date;
- Each organization will maintain a master list of current SOPs and LWIs, which are approved by management and assigned a revision number and effective date;
- A distribution list is maintained for the QAPP; and
- SOPs and LWIs are reviewed and revised in accordance with each organization's internal QA program.

The QAPP shall be reviewed at least annually and will be revised or amended as substantive changes are warranted. As the QAPP is revised, the revision number on the appropriate pages is incremented and the modified pages are released to the distribution list. A summary of the revisions with the date and a description of the revision is maintained on the signature page. The QAPP revision shall be submitted for approval by the same authorities that performed the original review.

1.6.2 Field and Onsite Laboratory Documentation

Field personnel from each organization shall retain copies of observations, calculations and derived data, calibration records, results, and/or reports in accordance with the BMP and each organization's QA program. Field observations will be documented in real time in bound field logbooks and will provide a record of field activities, observations, and measurements during sampling. Details regarding field and laboratory documentation are included in Sections 2 and 3.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 8 of 174
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1.6.3 Archival, Maintenance, and Retention of Project Files

Central project files are maintained in accordance with each organization's internal QA program. The central project files consist of completed field and onsite laboratory documentation, as well as fixed laboratory reports, computer program documentation, training records, and qualified subcontractor files.

Pursuant to permit regulations, project files will be retained for a period of at least five years from the date of the sample, measurement, report, or application, whichever is longer. Records are maintained electronically and/or in hard copy. Records will be maintained, archived, and retained in accordance with Section 11 of the BMP.

Record retention includes, but is not limited to, the following:

- Laboratory reports;
- Chain-of-custody (CoC) forms;
- Original monitoring data, including logbooks, field forms, electronic data capture, or other records in which monitoring data are first documented;
- Logs or other documents used to record field measurements, such as flow meter readings; and
- Calibration and maintenance logs for field and onsite laboratory equipment, as they relate to measurement of volume or monitoring quality.

1.6.4 Confidentiality and Proprietary Rights

Personnel may have access to confidential information concerning permittees operations and company operations. This knowledge may include expertise, technical information, technical software, and records related to operations, finance, accounting, sales, personnel, and management, policies, or other matters. Personnel may also have access to permittee and company trade secrets, including secret formulations, techniques, methods, processes, data, discoveries, developments, designs, improvements, inventions, and the like. The protection of these trade secrets and confidential information against unauthorized disclosure or use is of critical importance. Consequently, employees may be required to execute nondisclosure and confidentiality agreements.

1.7 Sample Handling, Documentation, and Chain-of-Custody Procedures

This section includes sampling and data collection procedures and policies for ensuring compliance with requirements of the General Permit applicable to exploration drilling activities to be conducted by Shell in the Chukchi Sea.

An essential part of the sampling activities of any environmental project is assuring the integrity of the samples from collection through data reporting. Environmental analyses involve the collection and shipping of numerous samples from different sampling sites. Sample labels and CoC forms are used to document identification and handling of samples from the time of collection through the completion of chemical and/or physical analysis. Documentation of the history of a sample will be prepared and maintained to demonstrate that the data are a true representation of the environmental media. The CoC record is used to demonstrate that a sample was not tampered with or altered in any way that may bias the

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 9 of 174
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analytical accuracy of the laboratory results. It is extremely important that CoC records be complete, accurate, and consistent.

This QAPP governs field and analytical sample handling, documentation, and CoC procedures for samples analyzed in the field at onsite laboratories and for samples transported to analytical subcontract laboratories. Additional details specific to the handling, documentation, and CoC procedures for the operational discharge compliance sampling program are included in Section 2; and for the EMP are included in Section 3.

The QA program of the fixed subcontract laboratory performing analyses governs laboratory sample control procedures.

1.7.1 Sample Containers and Preservation

Subcontract laboratories supply containers for fixed laboratory analyses. These containers are pre-cleaned and/or preserved in accordance with analytical method requirements. Details regarding the containers required for specific analyses can be found in Sections 2 and 3.

1.7.2 Sample Storage

Samples shall be stored in limited-access, temperature controlled areas while in the onsite laboratory or until packaged and shipped to the subcontract laboratory for analysis. In general, the acceptance criterion for sample storage is $4\pm 2^{\circ}\text{C}$. Thermal preservation requirements for specific analyses are outlined in Sections 2 and 3.

1.7.3 Sample Retention and Disposal

Samples will be retained under proper storage conditions in accordance with the SOP, LWI, and/or analytical methods. Analytical samples are retained and disposed of at the subcontract laboratories in accordance with the internal laboratory QA program.

1.7.4 Sample Labeling

As samples are collected and containerized, each sample is given a unique sample identification (ID) number. The sample ID is documented in the field logbook and on the CoC form. Sample IDs will be assigned in accordance with the specific procedures in Sections 2 and 3.

Each sample container must include the following information:

- Date - A six-digit number indicating the year, month, and day of collection, in this order;
- Time - A four-digit number indicating the military time of collection;
- Sample ID - A unique identification number which may contain the above information, but which distinguishes among samples collected from the same site;
- Preservative (if any);
- Sampler – Signature or initials of person collecting the sample; and
- Requested analyses.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 10 of 174
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Field QC samples (equipment blanks, field duplicates, etc.) are labeled as above, but are not identified as QC samples on the labels.

1.7.5 Chain-of-Custody Procedures

After collection, preservation, and identification, the sample is maintained under CoC procedures discussed in this section.

Sample custody records are the administrative records associated with the physical possession and/or storage history of each individual sample from sample collection to the final analytical result and sample disposal. Sample custody will be initiated by the sample collection records that identify for each sample the unique sample ID, date, time, location, and collector.

CoC forms document sample collection and shipment to the laboratory. CoCs are legal documents that record the transfer and disposition of collected environmental samples. The CoC form will identify the contents of each shipment and provide objective physical evidence of the possession history and integrity of each sample from collection through analysis. Every transfer of physical custody shall be recorded on the CoC form.

The chain-of-custody form must include:

- Sample originator (client);
- Sample identification / location;
- Project identification;
- Date and time of collection;
- Collector's name (printed);
- Sample type (e.g., liquid or sediment);
- Analyses required;
- Preservation used; and
- Signatory of release/acceptance through transport.

CoC procedures begin in the field with the collection and containerization of samples. A sample is considered under CoC if:

- The samples are in a person's possession, or
- The samples are in a person's view after being in that person's possession, or
- The samples were in a person's possession and then were locked or sealed to prevent tampering, or
- The samples are in a secure area.

As soon as each sample has been collected, containerized and labeled, it is entered on the CoC form. Each cooler should contain one CoC form representing all of the samples present in the cooler. The sampler shall complete the information on the form accurately and legibly. Any corrections to the CoC form must

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 11 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

be made using a single line through the incorrect entry. Corrections must be initialed and dated by the person making the change.

Once they have been properly labeled and logged, samples are packaged for shipment and sent to the laboratory with a CoC record sealed into each cooler. Before the sample cooler is shipped, the sampler must sign and date the CoC form under "Relinquished by". The original CoC form accompanies the samples during shipment; a copy is maintained by the shipper. Coolers containing samples will be custody sealed prior to shipment to subcontract analytical laboratories.

When samples are received at the subcontract laboratory, the laboratory sample custodian signs the CoC form as "Received by," and enters the date and time. The sample custodian shall carefully inspect samples as described in the laboratory SOP, including:

- Intact air-tight seal,
- Intact CoC,
- Evidence of alteration or damage to samples or packaging, and
- Completeness of accompanying records.

The laboratory's sample receipt record shall explicitly state the condition, including the measurement of the temperature blank or cooler temperature, for each incoming sample. The sampling task manager or his/her designee is notified of arrival and condition of each shipment, and of any discrepancies in accompanying paperwork, immediately after login inspection. After the sample log-in is complete, another copy of the CoC record, which includes laboratory sample numbers and notations of any discrepancies, is sent to the sampler identified on the CoC form and/or to Shell Regulatory Affairs, as instructed. The original CoC is filed in the laboratory, with the shipper's waybill or airway bill attached.

Samples for onsite laboratory analyses shall be kept in a designated secure area. CoC forms are not required for onsite laboratory samples. Sample collection activities and identification of samples shall be recorded in field logbooks.

1.7.6 Packaging and Shipment of Samples

Samples shall be packaged and shipped in accordance with each organization's QA program and SOPs/LWIs. Standard procedures for packaging and shipment of samples are necessary for the following reasons:

- 1) To protect persons handling, receiving and unpacking shipped samples;
- 2) To minimize loss of samples through breakage or delays in shipment;
- 3) To document sample integrity; and
- 4) To comply with applicable U.S. Department of Transportation (DOT) (49 CFR) and International Air Transport Association (IATA) regulations.

Details regarding specific procedures for packaging and shipping samples are included in Sections 2 and 3.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 12 of 174
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Environmental samples are samples of drilling fluids or other media where contamination is expected to be in relatively low concentrations. For the purpose of this QAPP, environmental samples are those samples whose toxic, flammable, corrosive or otherwise hazardous constituents represent less than one percent by volume.

1.8 Field and Laboratory QC Samples

The sampling designs for the operational discharge compliance sampling program and the EMP Plan of Study incorporate QC procedures and checks in both the field and laboratory to assess data quality. The following sections outline the most common types of field and laboratory QC samples that may be collected for the project. Sections 2 and 3 include specific types and frequencies of QC samples that will be collected and analyzed for operational discharge compliance sampling and the EMP. Section 3 also includes additional QC samples that will be collected for the EMP.

1.8.1 Field QC Samples

Field QC samples will be collected in the same type of sample containers and handled in the same manner as other field samples. The field QC samples will be assigned unique sample numbers and will be submitted to the analytical laboratory as routine samples. If nonconformances are detected in the results for field QC samples, the data associated with the QC samples will be evaluated to determine if the quality and/or usability of the data are affected.

1.8.1.1 Trip Blanks

Trip blanks are collected only for volatile organic carbon (VOC) samples. A trip blank consists of a uncontaminated sample of matrix that is transported from the laboratory to the sampling site, handled like an environmental sample, and returned to the laboratory for analysis without having been exposed to sampling procedures (i.e., not opened in the field). The results are used to assess contamination introduced during shipping and field handling procedures. Trip blanks are prepared and analyzed at the frequency of one per shipping container VOC samples.

1.8.1.2 Temperature Blanks

A temperature blank is a container of water that is packed and shipped to the laboratory with the field samples requiring preservation by cooling. Upon arrival of a cooler at the laboratory, the laboratory measures the temperature of the blank. This temperature reading is used to represent the conditions of the field samples during shipment to the laboratory. This information is used by both the laboratory and by the data reviewer. If the temperature blank exceeds the sample-specific thermal preservation criteria, the laboratory must notify Shell Regulatory Affairs immediately for guidance.

1.8.1.3 Field Duplicates

A field duplicate is a generic term for two (or more) field samples collected at the same time in the same location. Field duplicate samples are submitted as blind samples to the laboratory and are taken through all steps of the analytical preparation and analysis process in an identical manner. These samples are used to assess precision of the entire data collection activity, including sampling, analysis, and site heterogeneity. Field duplicates shall be collected where measurable contamination is likely to be present. If contaminant levels in the duplicates are below detection limits, they cannot be used for data quality

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 13 of 174
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assessment. Field duplicates are collected at a frequency of 10% of the field samples (one field duplicate sample for every 10 or fewer field samples).

There are two categories of field duplicate samples defined by the collection method: co-located field duplicates and subsample field duplicates. Co-located field duplicates are two or more independent samples collected from side-by-side locations at the same point in time and space so as to be considered identical. Co-located samples are collected from adjacent locations, or water samples collected from the same sampling point at the same time that have not been homogenized. Subsample field duplicate samples are obtained from one sample collection at one sample location. The sample is homogenized and then subsampled in the field to form an original and duplicate sample.

Drilling fluid samples may contain gradients of chemical constituents. It is therefore necessary to thoroughly mix a quantity of drilling fluid and then split the resulting homogenized material into two separate sample containers to obtain identical field duplicate samples. The contamination risk is mitigated through the use of specially cleaned containers and properly decontaminated or disposable sampling equipment and implements for mixing and transferring the sample material.

1.8.1.4 Matrix Spikes and Matrix Spike Duplicates (MS/MSDs)

A matrix spike (MS) is performed by spiking one of a pair of duplicate samples with a known quantity of target analyte and extracting and analyzing both the spiked and the unspiked samples. In the absence of matrix interferences, the difference between the analytical results for these two duplicates will yield an acceptable recovery rate for the spike compound. If matrix interferences are present, their effect on the analytical results for the MS sample can indicate a similar effect on other samples of a similar matrix.

Matrix spikes may also be used to measure precision and accuracy of the sampling and analysis process by analyzing two spiked aliquots and one unspiked aliquot of a sample. This second spiked sample aliquot is called a MS duplicate (MSD). Accuracy is measured by calculating the difference between the measured spike concentration and the known concentration added to the MS and MSD. The closer the two measured concentrations are to the true concentration, the higher the level of accuracy in the analytical process. Precision is measured by calculating the difference between the two spike concentrations recovered in the MS and MSD. The greater the difference between the two recovered spike amounts, the lower the precision of the sampling and analysis process.

Because three separate aliquots, or portions, of sample have to be analyzed when performing an MS/MSD, it is often necessary to submit double or triple the volume of sample for an MS/MSD than that required for a normal sample. The MS/MSD samples are not separate samples, and the same sample number will be assigned to the primary (parent) sample and the extra volume supplied for the laboratory MS/MSD. CoC forms will indicate the sample designated for MS/MSD when additional material is provided. MS/MSD samples will be collected at a frequency of 5% of the field samples (one MS/MSD pair for every 20 field samples).

1.8.2 Laboratory QC Samples

Laboratory samples will be processed and analyzed in analytical batches or sample delivery groups (SDGs) of 20 or fewer field samples plus laboratory QC. A suite of QC samples that monitors the accuracy and precision of the methods will be incorporated into each batch; these samples are defined below. In addition to these QC samples, surrogate internal standards will be spiked into each sample

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 14 of 174
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analyzed for organic compounds. Laboratory QC and acceptance criteria for the specific analytical methods are included in Sections 2 and 3.

1.8.2.1 Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. A method blank is prepared and analyzed with every analytical batch. The method blank is carried through the complete sample preparation and analytical procedure and is used to assess possible contamination resulting from the analytical process.

The presence of analyte in a method blank at a concentration exceeding the analytical data quality objective indicates the need for further assessment of the data. The source of contamination should be investigated, and measures must be taken to correct, minimize, or eliminate the problem. No analytical data shall be corrected for the presence of analytes in blanks.

1.8.2.2 Laboratory Control Sample

A laboratory control sample (LCS) is a sample of known composition that is spiked with all target analytes. The LCS is used with each analytical batch to determine whether the method is in control. Each analyte in the LCS shall be spiked at a level less than or equal to the midpoint of the calibration curve, which is defined as the median point of the curve instead of the middle of the range. The LCS shall be carried through the complete sample preparation and analysis procedure. The LCS cannot be used as the continuing calibration verification (CCV).

At least one LCS shall be included in every analytical batch. If more than one LCS is analyzed in an analytical batch (e.g., LCS duplicate [LCSD]), results from all LCSs shall be reported. A failure of an analyte in any of the LCSs shall require appropriate corrective action, including qualification of the failed analyte in all of the samples, as required.

1.8.2.3 Surrogates

Surrogates are compounds similar to the target analytes in chemical composition and behavior, but not normally found in environmental samples. Surrogates are used to evaluate accuracy, method performance, and extraction efficiency. Surrogates shall be added to environmental samples, controls, and blanks in accordance with the method requirements.

If a surrogate recovery is outside the acceptance limit, corrective action must be performed. After the system problems have been resolved and system control has been reestablished, the sample should be re-prepared and reanalyzed. If corrective actions are not performed or are ineffective, an appropriate flag shall be applied to the sample results.

1.8.2.4 Internal Standards

Internal standards (ISs) are known amounts of standards that are added to a portion of a sample or sample extract and carried through the entire determination procedure. ISs are used as a reference for calibration and for controlling the precision and bias of the analytical method. ISs shall be added to environmental samples, controls, and blanks, in accordance with the method requirements.

If the IS results are outside of the acceptance limits, corrective actions shall be performed. After the system problems have been resolved and system control has been reestablished, all samples analyzed

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 15 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

while the system was malfunctioning shall be reanalyzed. If corrective actions are not performed or are ineffective, an appropriate flag shall be applied to the sample results.

1.9 Project Assessment and Oversight

The QA programs are designed to measure performance and to monitor adherence to corporate QA policies, method, and project-specific requirements and regulatory requirements. Quality assessment is the responsibility of QA staff or designees, and is performed in cooperation with the affected operating group personnel. The purpose of this section is to establish standard procedures for quality assessment and the formulation of assessment criteria. Systems for corrective action are discussed in Section 1.10.3.

1.9.1 Project Audits/Assessments

The following project audits and assessments are planned:

- *Pre-mobilization audit (readiness review).* Prior to project mobilization, a systematic evaluation of readiness for field activities will be performed.
- *Well records review.* Once per well, a review of the documents and records associated with drilling activities will be reviewed. Verify accuracy and completeness. Verify that all planned activities were documented and that all associated documentation has been completed.
- *Subcontract laboratory sample receipt information.* Verify accuracy and completeness. Verify that discrepancies were documented and resolution of any potential data quality issues. Verify that all planned samples were collected and documented. Compare planned samples with the CoC forms and laboratory login information for samples actually submitted to the laboratory. Verify that corrective action is documented, if required and appropriate, for any data quality issues identified.

1.9.2 Audit Reporting

The response to audit or assessment findings may require written documentation, verbal communication, or formal corrective action. The timeframe and format of the response depends on the audit or assessment findings. Findings should include a discussion of the audit, explaining each finding, its significance, and whenever possible, its root cause. Deviations from plans, policies or SOP, if any, shall be discussed in terms of whether they were warranted by the circumstances of the project, and why. Finally, recommended corrective actions should be provided, if required and appropriate, as determined by the manager and technical personnel involved in the audit.

1.9.3 Corrective Action

Feedback and corrective action are required when deviations from documented policies, procedures or QC, if any, occur. These deviations may be identified through audits, data review and assessment, or staff feedback. The following sections describe the general procedures to be followed when departures from documented policies, procedures, or QC have occurred.

1.9.3.1 Audit Findings

The Shell Compliance Engineer and/or QA Auditor (member of the Shell Regulatory Affairs/Science Department) shall be responsible for initiating and recommending corrective action, if any, in response to

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 16 of 174
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audit findings. Items requiring corrective action may require written documentation addressed to the Operations Manager/Drilling Superintendent. Corrective action steps shall be fully documented to assist in determining future corrective action procedures. When satisfactory progress has been achieved on each requested action, the Operations Manager/Drilling Superintendent or designee enters descriptions of actions and results on the form, retains a copy and returns the original to the Shell Compliance Engineer to close the loop. The Shell Compliance Engineer maintains a file of Service Quality Non-Conformance Reports and keeps track of their progress. Unresolved corrective action requests, if any, are listed in a QA report to Management.

1.9.3.2 Data Quality Issues

Staff reviewing permit compliance data shall be responsible for requesting corrective actions in response to deficiencies that affect data quality and usability. To identify any potential impacts on the analytical results, a data usability summary shall include an evaluation of the data as applicable to the analytical method and General Permit requirements. Repetitive QC problems may result in staff retraining or subcontractor disqualification.

1.9.3.3 Staff Feedback

Each person involved in the data accumulation process shall be responsible for recognizing and reporting deviations, if any, from documented policies, procedures, and/or QC. If required and appropriate, deviations shall be documented and addressed to Shell Regulatory Affairs. Analysts, Compliance Specialists, supervisors, and QC personnel shall use this system to document problems, deviations, and discrepancies encountered during sample collection, sample analysis, or data reporting, if any.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 17 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 18 of 174
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2.0 Compliance Sampling Program for Operational Discharges

This section presents the applicable compliance requirements for operational discharges in the Authorization to Discharge under the NPDES for Oil and Gas Exploration Facilities on the OCS in the Chukchi Sea, Permit Number AKG-28-8100 issued by the USEPA, in compliance with the provisions of the Clean Water Act, 33 U.S.C. §1251 et seq., effective November 28, 2012.

2.1 Introduction and Overview

In the management of its activities, Shell has contracted with M-I SWACO (M-I SWACO) for its compliance assurance for the exploration program in the Chukchi Sea on the drillship M/V *Noble Discoverer*. This section addresses those General Permit compliance tasks that will be performed by M-I SWACO under contract to the permittee during offshore drilling exploration. General Permit discharge limitations and monitoring requirements applicable to the offshore drilling exploration program in the Chukchi Sea are presented in Tables 2-1 through 2-5. The following sections detail the compliance monitoring requirements for each discharge.

AKG-28-8100– <i>Noble Discoverer</i> Revision 0, Effective Date May 2013	Page 19 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 20 of 174
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**Table 2-1 Effluent Limitations and Monitoring Requirements for Water-Based Drilling Fluids/Drill Cuttings
(Discharge 001)**

Discharge	Effluent Parameter	Effluent Limitations		Monitoring Requirements	Seasonal Restrictions
		Average Monthly Limit	Maximum Daily Limit		
Discharge 001 Water-Based Drilling Fluids and Drill Cuttings	SPP toxicity ^{note 1,10}	Minimum 96-hour LC ₅₀ of 30,000 ppm		Weekly Grab & End of Well ^{note 2}	<u>Open-water:</u> Discharges must be greater than 1 meter below the surface of the receiving water when between 5 and 20 meters isobaths.
	Drilling fluids and cuttings	Static Sheen Test ^{note 3,10}		Daily Grab	
	Free oil	No Discharge ^{note 4,10}		Daily Grab	
	Diesel oil	No Discharge ^{note 5,10}		Daily Grab	
	Mercury	1 mg/kg ^{note 6}		Grab Once/well	<u>Unstable or broken ice:</u> Discharges shoreward of 20 meter isobaths (as measured from the MLLW) are allowed only when the discharge is pre-diluted to a 9:1 ratio of seawater to drilling fluids and cuttings.
	Cadmium	3 mg/kg ^{note 6}		Grab Once/well	
	pH	Report (s.u.)		Grab Once/ well	
	Total Aqueous Hydrocarbons (TaqH)	Report (µg/L)		Grab Once /well ^{note 7}	
	Total Aromatic Hydrocarbon (TAH)	Report (µg/L)		Grab Once /well ^{note 8}	
	Total volume	Report (gal)		Daily Estimate ^{note 9}	

Notes:

LC₅₀ = lethal concentration, 50% (in water, that kills 50% of the inhabitants in a given time)
mg/kg = milligram per kilogram
MLLW = Mean lower low water
µg/L = microgram per liter
ppm = parts per million
s.u. = standard units
SPP = suspended particulate phase

- As determined by the 96-hour suspended particulate phase (SPP) toxicity test in accordance with Appendix 2 to Subpart A of 40 CFR Part 435, Drilling Fluids Toxicity Test. The discharge of water-based drilling fluids or drill cuttings generated using drilling fluids with a daily minimum or monthly average minimum 96-hour LC₅₀ of less than 30,000 ppm is prohibited. If inclement weather conditions affect timely deliveries of samples, the permittee must notify EPA within 24 hours and document the conditions and rationale in the following monthly DMR.
- See requirement of Section II.B.5.b. (Mineral Oil Pill). At the end-of-well, a sample must be collected for SPP toxicity testing where no mineral oil pill is used. The end-of-well sample can also serve as the monthly monitoring sample.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 21 of 174
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*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

3. No discharge allowed upon failure of the static sheen test as determined in accordance with Appendix 1 to Subpart A of 40 CFR Part 435, Static Sheen Test.
4. As determined by the static sheen test in accordance with Appendix 1 to Subpart A of 40 CFR Part 435, Static Sheen Test.
5. The discharge of drilling fluids or drill cuttings generated using drilling fluids which contain diesel oil is prohibited. Compliance will be demonstrated by gas chromatograph (GC) analysis of drilling fluid collected from the drilling fluid used at the greatest well depth ("end-of-well" sample) and of any drilling fluids or cuttings which fail the static sheen test compared to GC analysis of diesel oil in storage at the facility. Whenever drilling fluids or drill cuttings fail the static sheen test, the permittee is required to analyze an undiluted sample of the material which failed the test to determine the presence or absence of diesel oil in accordance with EPA SW846 Method 8015C (2007). Gas chromatography/mass spectrometry (GC/MS) may be used if an instance should arise where the permittee and the Director or DEC determine that greater resolution of the drilling fluid "fingerprint" is needed for a particular drilling fluid sample.
6. Dry weight in the stock barite. Results must be expressed as mg/kg (dry weight) of barite. The permittee must analyze a representative sample of stock barite once prior to drilling each well and submit the results with the DMR for the month in which drilling operations commence for the respective well. If any analytical result exceeds the mercury or cadmium effluent limitations in Table 1, the permittee must report the results to the Director in accordance with Section III.G., including the twenty-four hour notice of noncompliance requirement, of this general permit. If the permittee uses the same supply of stock barite to drill subsequent wells, the permittee may submit the same analysis for those subsequent wells if no new supplies of barite have been received since the prior analysis. In this case, the DMR should state that no new barite was received since the last reported analysis.
7. As determined by summing the results of EPA Method 602 (plus Xylenes) or EPA Method 624 to quantify monoaromatic hydrocarbons and to measure TAH and EPA Method 610 or EPA Method 625 to quantify polynuclear aromatic hydrocarbons listed in EPA Method 610. Sample must be collected at the same time as the SPP toxicity test, to the extent practicable, and at the end of well.
8. As determined by EPA Method 602 (plus Xylenes) or EPA Method 624. Sample must be collected at the same time as the SPP toxicity test, to the extent practicable, and at the end of well.
9. Record separate total daily volumes of drilling fluids and drill cuttings and report the separate daily volumes in the End of Well Report. Report combined total volume of drilling fluids and drill cuttings discharged on a calendar day in the DMR.
10. The permittee must report the following discharge occurrences of noncompliance to the Director in accordance with Section III.G.I., including the twenty-four hour notice of noncompliance requirement, of this general permit: (a) exceedance of the SPP toxicity limitation; (b) failure of the static sheen test; or (c) presence of diesel oil.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 22 of 174
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**Table 2-2 Discharge Rate Limitations and Monitoring Frequency for Water-Based Drilling Fluids and Drill Cuttings
(Discharge 001)**

Water Depth ^{note 1}	Rate of Discharge ^{note 2}	Measurement Frequency	Sample Type
0 to 5 meters	No discharge	Hourly during discharge ^{note 3}	Estimate
>5 to 20 meters	500 bbl/hr		
>20 to 40 meters	750 bbl/hr		
>40 meters	1000 bbl/hr		

Notes:

bbl/hr = barrels per hour

1. As measured from the MLLW.
2. Rate of discharge limitations do not include entrained seawater.
3. The maximum daily discharge limitation is calculated by multiplying the maximum hourly rate of discharge by 24 hours. For purposes of reporting, each hourly measurement must be recorded for each calendar day of discharge within the month. The monthly average limit is the average of the maximum daily hourly rate for each calendar day.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 23 of 174
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Table 2-3 Effluent Limitations and Monitoring Requirements for Deck Drainage (Discharge 002)

Discharge	Effluent Parameter	Effluent Limitations	Monitoring Requirements	Approach
Discharge 002 Deck Drainage	pH	s.u.	Monthly sample	
	Free oil	No discharge ^{note 1}	Grab sample and visual per discharge event	
	Total Volume (gal)	-	Monthly estimate	
	TAqH	µg/L	Grab sample per discharge event ^{note 2,4}	
	TAH	µg/L	Grab sample per discharge event ^{note 3,4}	
	WET	TU _c	II.A.13.g.1.(page 22) and II.A.13.n.(page 26) of the NPDES General Permit	Use rapid toxicity test 4X/well as initial screen.

Notes:

µg/L = microgram per liter

gal = gallons

s.u. = standard units

WET = whole effluent toxicity

1. Once per discharge event, the permittee must sample deck drainage discharges that are processed through an oil-water separator and test for sheen using the static sheen test in accordance with Appendix 1 to Subpart A of 40 CFR Part 435, Static Sheen Test. For discharges during unstable or broken ice conditions, a water temperature that approximates surface water temperatures after breakup must be used. During periods of discharge, the permittee must also conduct a visual observation for visual sheen as determined by the presence of a film or sheen upon or a discoloration of the surface of the receiving water.
2. As determined by summing the results of EPA Method 602 (plus Xylenes) or 624 to quantify monoaromatic hydrocarbons to measure TAH and EPA Method 610 or EPA Method 625 to quantify polynuclear aromatic hydrocarbons.
3. As determined by EPA Method 602 (plus Xylenes) or EPA Method 624.
4. Sample must be collected from the oil-water separator effluent.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 24 of 174
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Table 2-4 Effluent Limitations and Monitoring Requirements for Sanitary and Domestic Wastes (Discharges 003 and 004)

Discharge	Effluent Parameter	Effluent Limitations		Monitoring Requirements	
		Average Monthly Limit	Maximum Daily Limit	Sample Frequency	Sample Type
Discharge 003 Sanitary Waste	Flow (mgd)	----	----	Daily	Measured/Recorded
	BOD ₅	30 mg/L	60 mg/L	Weekly	Grab or composite ^{note 1}
	TSS	30 mg/L	60 mg/L	Weekly	Grab or composite ^{note 1}
	Floating solids	No discharge		Daily	Visual ^{note 2}
	Foam	No discharge		Daily	Visual ^{note 2}
	Oily Sheen	No discharge		Daily	Visual ^{note 2}
	pH	6.5-8.5 s.u.		Weekly	Grab
	Fecal Coliform Bacteria	100 colonies/100 mL ^{note 3}	200 colonies/100 mL	Weekly	Grab
	Total Residual Chlorine ^{note 5}	----	1.0 mg/L	Weekly	Grab
Discharge 004 Domestic Waste	pH	Report s.u.		Monthly	Grab
	Floating solids, garbage, foam	No discharge		Daily ^{note 2}	Visual
	Flow (mgd)	Report		Monthly	Estimated/Recorded

Notes:

mgd = million gallons per day
mg/L = milligram per liter
mL = milliliters
s.u. = standard unit

1. Composite samples may be collected in lieu of grab samples and must consist of at least four equal volume grab samples, two of which must be taken during periods of peak flow.
2. The permittee must monitor by observing the surface of the receiving water in the vicinity of the outfall(s) during daylight at the time of maximum estimated discharge and during conditions when observations on the surface of the receiving water are possible in the vicinity of the discharge. The observations and time of day must be recorded. The numbers of days floating solids, garbage, foam or oily sheen are observed must be recorded and reported in the DMR.
3. Must be reported as the geometric mean.
4. If inclement weather conditions affect timely deliveries of samples, the permittee must notify EPA within 24 hours document the conditions and rationale in the following monthly DMR.
5. Must be maintained as close to this concentration as possible. Sample must be collected immediately after chlorination and prior to any commingling of the waste streams. The analytical detection limit for this parameter is 0.1 mg/L. Residual chlorine may be monitored according to test procedures approved under 40 CFR Part 136 or using a Hach Test Kit capable of measuring free chlorine in the range of 0-3.5 mg/L with a sensitivity of 0.1 mg/L or better. Monitoring is not required if chlorine is not used as a disinfectant or for facilities serving fewer than 10 persons. One composite sample must consist of at least four equal volume grab samples, two of which must be taken during periods of peak flow.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 25 of 174
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Table 2-5 Effluent Limitations and Monitoring Requirements for Miscellaneous Discharges

Discharge	Effluent Parameter	Effluent Limitations		Monitoring Requirements	
		Average Monthly Limit	Maximum Daily Limit	Sample Frequency	Sample Type
Discharge 005 Desalination Unit Wastes	pH	Report (s.u.)		Monthly	Grab
	Free oil	No discharge ^{note 1,2}		Once/discharge	Visual /Grab
	Total Volume	Report (gal)		Monthly	Estimate
	WET	Report (TU _c)		Use rapid toxicity test 4X/well as initial screen.	Collect grab sample for analysis if results show potential toxicity or 1X/well if discharge >10,000 gal during 24 hr and if chemicals are added to the system.
Discharge 006 Blowout Preventer Fluid	pH	Report (s.u.)		Monthly	Grab
	Free oil	No discharge ^{note 1,2}		Once/discharge	Visual /Grab
	Total Volume	Report (gal)		Monthly	Estimate
Discharge 007 Boiler Blowdown	pH	Report (s.u.)		Monthly	Grab
	Free oil	No discharge ^{note 1,2}		Once/discharge	Visual /Grab
	Total Volume	Report (gal)		Monthly	Estimate
	WET	Report (TU _c)		Use rapid toxicity test 4X/well as initial screen.	Collect grab sample for analysis if results show potential toxicity or 1X/well if discharge >10,000 gal during 24 hr and if chemicals are added to the system.
Discharge 008 Fire Control System Test Water	pH	Report (s.u.)		Monthly	Grab
	Free oil	No discharge ^{note 1,2}		Once/discharge	Visual /Grab
	Total Volume	Report (gal)		Monthly	Estimate
	WET	Report (TU _c)		Use rapid toxicity test 4X/well as initial screen.	Collect grab sample for analysis if results show potential toxicity or 1X/well if discharge >10,000 gal during 24 hr and if chemicals are added to the system.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 26 of 174
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*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

Discharge	Effluent Parameter	Effluent Limitations		Monitoring Requirements	
		Average Monthly Limit	Maximum Daily Limit	Sample Frequency	Sample Type
Discharge 009 Non-Contact Cooling Water	pH ^{note 3}	Report (s.u.)		Monthly	Grab
	Free oil	No discharge ^{note 1}		Daily	Visual
	Total Volume	Report (gal)		Daily ^{note 4}	Estimate
	Temperature	Report (°F)		Continuous ^{note 4}	Measure
	WET	Report (TU _c)		Use rapid toxicity test 4X/well as initial screen.	Collect grab sample for analysis if results show potential toxicity or 1X/well if discharge >10,000 gal during 24 hr and if chemicals are added to the system.
Discharge 010 Uncontaminated Ballast Water	pH	Report (s.u.)		Monthly	Grab
	Free oil	No discharge ^{note 1,2}		Once/discharge	Visual /Grab
	Total Volume	Report (gal)		Monthly	Estimate
Discharge 011 Bilge Water	pH	Report (s.u.)		Monthly	Grab
	Free oil	No discharge ^{note 5}		Once/discharge & Daily	Grab/Visual
	Total Volume	Report (gal)		Monthly	Estimate
	WET	Report (TU _c)		Use rapid toxicity test 4X/well as initial screen.	Collect grab sample for analysis if results show potential toxicity or 1X/well if discharge >10,000 gal during 24 hr and if chemicals are added to the system.
Discharge 012 Excess Cement Slurry	pH	Report (s.u.)		Monthly	Grab
	Free oil	No discharge ^{note 1}		Once/discharge	Visual
	Total Volume	Report (gal)		Monthly	Estimate
Discharge 013 Mud, Cuttings & Cement at Sea Floor	Free oil	No discharge ^{note 1}		Daily	Visual
	Total Volume	Report (gal)		Monthly	Estimate

Notes:

°F = degrees Fahrenheit

gal = gallons

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 27 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.		

*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

s.u. = standard units

TU_c = chronic toxic units

WET = whole effluent toxicity

1. Once per discharge event, the permittee must conduct a visual observation for visual sheen as determined by the presence of a film or sheen upon or a discoloration of the surface of the receiving water. The permittee must monitor by observing the surface of the receiving water in the vicinity of the outfall(s) during daylight at the time of maximum estimated discharge and during conditions when observations on the surface of the receiving water are possible in the vicinity of the discharge. The observations and time of day must be recorded. The number of days sheen is observed must be recorded and reported in the DMR. For discharges during unstable or broken ice conditions, a water temperature that approximates surface water temperatures after breakup must be used.
2. If visual observations of the discharge are not possible, the permittee must sample (grab sample) the discharge and test for sheen using the static sheen test in accordance with Appendix 1 to Subpart A of 40 CFR Part 435.
3. pH monitoring and reporting is required. pH limit of 6.5-8.5 applies if chemicals are added to the system.
4. Estimated daily discharge volume and maximum and minimum recorded daily temperature must be reported for each outfall.
5. Once per discharge event, the permittee must sample bilge water discharges that are processed through an oil-water separator and test for sheen using the static sheen test in accordance with Appendix I to Subpart A of 40 CFR Part 435. For discharge during unstable or broken ice conditions, a water temperature that approximates surface water temperatures after breakup must be used. On a daily basis during discharge, the permittee must also conduct a visual observation for visual sheen as determined by the presence of a film or sheen upon or discoloration of the surface of the receiving water. The permittee must monitor by observing the surface of the receiving water in the vicinity of the outfall(s) during daylight at the time of maximum estimated discharge and during conditions when observations on the surface of the receiving water are possible in the vicinity of the discharge. The observations and time of day must be recorded. The number of days sheen is observed must be recorded and reported in the DMR.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 28 of 174
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2.2 Operational Discharge Compliance Program Roles and Responsibilities

Communication and coordination between compliance monitoring personnel, drilling operations management officials, and drillship operations officials will be critical to ensuring compliance with General Permit requirements. Compliance monitoring personnel must have a general understanding of oil and gas drilling procedures and drillship operations. They must verify that they are aware of the schedule for drilling operations and planned discharges of drilling fluids as well as discharges of materials related to drillship operations that are regulated under the General Permit.

The primary roles and responsibilities for individuals and teams responsible for implementing the operational discharge compliance program are defined in the following sections.

2.2.1 Operations Manager/Drilling Superintendent

Operations Managers and/or Drilling Superintendents are responsible for recognizing the requirements of this manual in their planning and budgeting and for implementing the QA program as assigned in this chapter. Operations Managers/Drilling Superintendents have overall responsibility for the technical operation of the permit compliance program. Operations Managers/Drilling Superintendents may assign personnel to assist in implementation of the quality program. Operations Managers/Drilling Superintendents are specifically responsible for:

- Defining processes to confirm that personnel are free from any commercial, financial, or other undue pressures that may affect the quality of their work;
- Defining the minimum level of qualification, experience, and skills necessary for positions in the environmental laboratory;
- Specifying and documenting the responsibility, authority, and relationship of personnel who manage, perform, or verify work affecting the quality of data; and
- Providing supervision by persons familiar with the procedures, the objective of the procedures and the assessment of the results.

2.2.2 Wells HSE Department

The Wells HSE Department has overall responsibility for the health and safety of employees as well as implementation of environmental regulatory programs. The HSE Department is specifically responsible for providing health and safety oversight in compliance with the requirements of the Shell HSE Program.

2.2.3 Shell Regulatory Affairs Compliance Engineer

The Shell Regulatory Affairs Compliance Engineer has independent reporting authority from the Operations Manager/Drilling Superintendent. The Compliance Engineer may assign personnel to assist in implementation of the quality program. The responsibilities of the Compliance Engineer are to:

- Conduct regularly scheduled audits of quality programs; and
- Advise operational managers of deficiencies (if any) in quality programs or performance.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 29 of 174
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2.2.4 M-I SWACO Compliance Supervisor

The M-I SWACO Compliance Supervisor reports to the Wells Delivery Manager and is responsible for implementing the technical operation of the permit compliance program. The M-I SWACO Compliance Supervisor may assign personnel to assist with specific duties. Specific responsibilities of the M-I SWACO Compliance Supervisor include:

- Training Compliance Specialists;
- Coordinating field laboratory assignments;
- Providing overall direction to, and coordination of, quality programs as related to documenting compliance with the General Permit;
- Providing, and replacing as necessary, the equipment required for compliance tests;
- Approving and publishing QAPPs, SOPs, and LWIs;
- Reviewing Daily Activity Reports and associated records; and
- Archiving records at the completion of a drilling interval.

2.2.5 M-I SWACO Compliance Specialist

Personnel are responsible for complying with QA/QC requirements that pertain to their technical function. Each M-I SWACO Compliance Specialist shall have a combination of experience and education to adequately demonstrate a specific knowledge of their function and a general knowledge of operations, test methods, QA/QC procedures, and records management. M-I SWACO Compliance Specialists shall be responsible for recognizing and reporting deviations from documented policies, procedures, and/or QC to the Operations Manager/Drilling Superintendent or the Shell Compliance Engineer.

The responsibility for implementing the QA program ultimately rests with the M-I SWACO Compliance Specialist. The M-I SWACO Compliance Specialist is specifically responsible for:

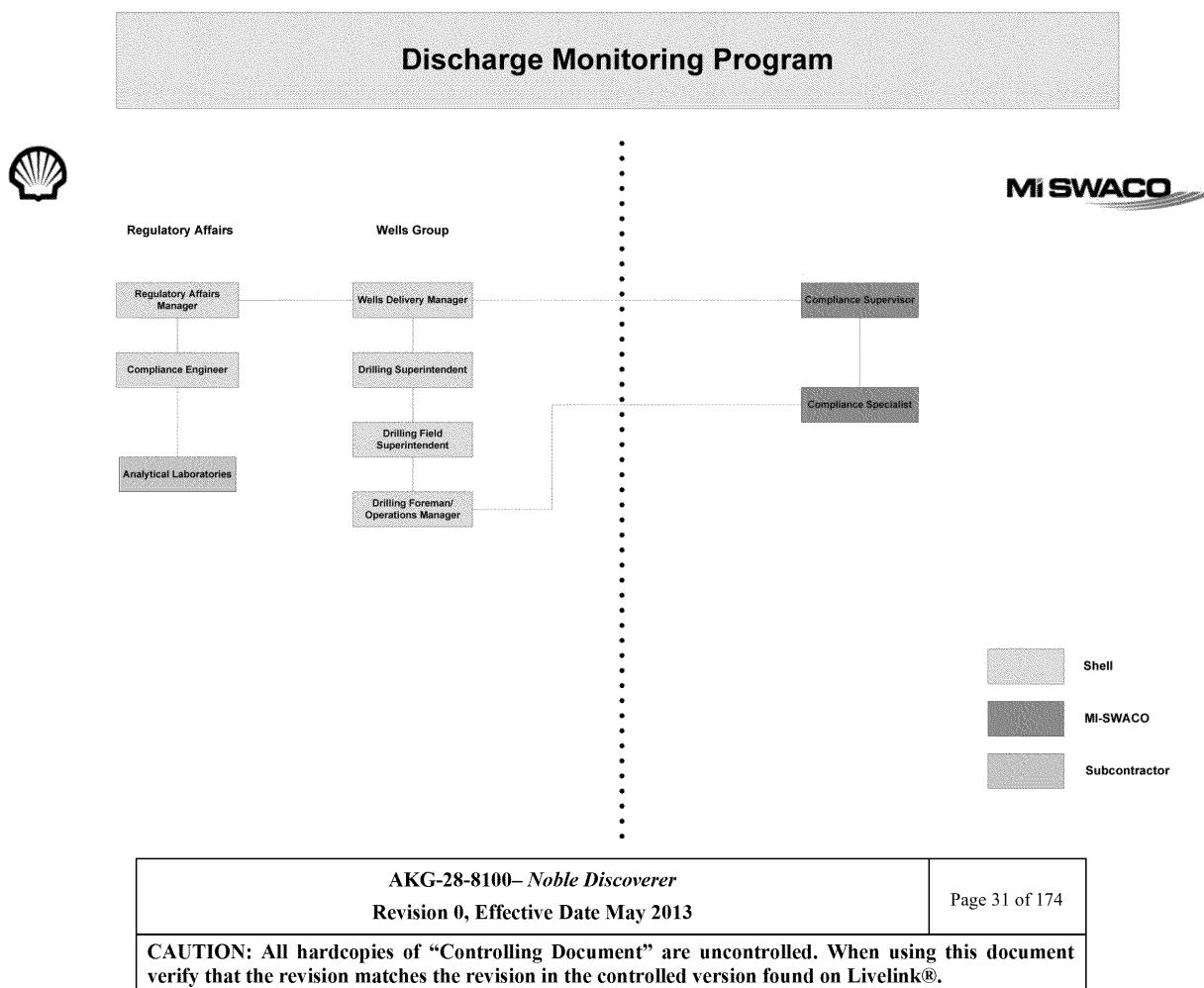
- Maintaining technical proficiency in the compliance procedures;
- Maintaining records for field equipment;
- Maintaining and calibrating equipment for compliance tests;
- Collecting and/or analyzing effluent samples;
- Transferring documents to the records custodian at the end of a drilling interval;
- Providing copies of analytical reports to the permittee; and
- Reporting deviations from procedures to supervisory personnel.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 30 of 174
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2.2.6 Project Organization Chart

Figure 2-1 Organizational Structure for the Operational Discharge Compliance Program



2.3 Data Quality Objectives

The overall DQOs for the operational discharge monitoring program are to ensure that data generated for compliance with the General Permit are scientifically valid, are legally defensible, and support project objectives. The DQOs for the monitoring of operational discharges address the following General Permit requirements:

- Ensure that samples and measurements taken for the purpose of monitoring are representative of the monitored activity;
- Collect and analyze effluent samples in accordance with the methods specified in 40 CFR Part 435 and 40 CFR Part 136; and
- Collect and analyze samples of the type, frequency, quantity, and quality to meet the effluent limitations and monitoring requirements outlined in Section II of the General Permit.

2.4 Field Sampling

The following sections outline the operational discharge compliance sampling program design, which is intended to meet project DQOs and the effluent limitations and monitoring required by the General Permit.

2.4.1 Sampling, Measurement, and Observation Locations

This section presents discharge sampling, flow/volume measurement, and observation locations. Samples of treated discharge media will be collected after the final treatment system component and prior to the applicable discharge point or caisson. Discharge flow rates will either be calculated by estimating the total volume discharged or by using a dedicated inline flow meter. Visual discharge observations for sheen, floating solids, or other residues will be conducted from vantage points aboard the surface of the drill ship that allow for unobstructed observation of the receiving waters in accordance with M-I SWACO SOP 3005.

Table 2-6 presents the discharge sampling locations, flow/volume measurement locations, and visual observation locations as well as station identifiers and ship sample location designators. Ship sample locations correlate to points identified on the *Noble Discoverer* in Figure 1 (Appendix D to the BMP).

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 32 of 174
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Table 2-6 Discharge Sampling Locations

Discharge	Ship Location/ Station ID ¹	Sample Location	Type of Measurement	Effluent Parameter
Discharge 001 Drilling Fluids and Drill Cuttings	Figure 2	Stock barite	Analytical sample	Mercury and Cadmium
		Drilling fluids and cuttings from shale shakers (prior to discharge into caisson trough); Mud Tank	Analytical sample	SPP toxicity
				TAH
				TAqH
				Diesel oil
			Field sample	pH, Static sheen
			Calculation/Measurement	Total Volume (gal)
Discharge 002 Deck Drainage	Figures 1, 2, & 3	OWS Effluent line; Flow meter on OWS	Analytical sample	Free Oil (visual sheen)
				TAH
				TAqH
				Initial tox screen/WET
			Field sample	pH
			Calculation/Measurement	Total Volume (gal)
Discharge 003 Sanitary Waste	Figure 2 & 3	MSD Effluent Line	Analytical sample	Free Oil (visual sheen)
				BOD ₅
				TSS
				Fecal Coliform Bacteria
			Field sample	pH, Total residual chlorine
			Flow meter reading	Flow Volume (mgd)
Discharge 004 Domestic Waste	Figure 1 & 3	MSD Effluent Line	Visual observation	Oily Sheen, Floating solids & garbage, Foam
			Field Sample	pH
			Estimate	Flow Volume (mgd)
Discharge 005 Desalination Unit Wastes	Figures 1, 2, & 3	Desalination Unit Effluent Line	Visual observation	Floating solids & garbage, Foam
			Analytical sample	Initial tox screen/WET
			Field sample	pH
			Calculation/Measurement	Total Volume (gal)
Discharge 006 Blowout Preventer Fluid	Not depicted	Holding tank	Visual observation	Free Oil (visual sheen)
			Field sample	pH
			Calculation/Measurement	Total Volume (gal)

*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

Discharge	Ship Location/ Station ID ¹	Sample Location	Type of Measurement	Effluent Parameter
Discharge 007 Boiler Blowdown	Figures 1, 2 & 3	Holding Tank	Analytical sample	Initial tox screen/WET
			Field sample	pH
			Calculation/Measurement	Total Volume (gal)
			Visual observation	Free Oil (visual sheen)
Discharge 008 Fire Control System Test Water	Figures 1, 2 & 3	Common manifold	Analytical sample	Initial tox screen/WET
			Field sample	pH
			Calculation/Measurement	Total Volume (gal)
			Visual observation	Free Oil (visual sheen)
Discharge 009 Non-contact Cooling Water	Figures 1, 2, & 3	Common manifold	Analytical sample	Initial tox screen/WET
			Field sample	pH
			Calculation/Measurement	Total Volume (gal)
			Visual observation	Free Oil (visual sheen)
			Data logger	Temperature (continuous)
Discharge 010 Uncontaminated Ballast Water	Not depicted	Ballast Water Discharge Line	Field sample	pH
			Calculation/Measurement	Total Volume (gal)
			Visual observation	Free Oil (visual sheen)
Discharge 011 Bilge Water	Figures 2 & 3	OWS Effluent Line	Analytical sample	Initial tox screen/WET
			Field sample	pH, Static sheen
			Flow meter reading	Total Volume (gal)
			Visual observation	Free Oil (visual sheen)
Discharge 012 Excess Cement Slurry	Figures 1 & 3	Cement Unit Mix Tanks	Field sample	pH
			Calculation/Measurement	Total Volume (gal)
			Visual observation	Free Oil (visual sheen)
Discharge 013 Muds, Cuttings, and Cement at the Seafloor	Not depicted	N/A	Calculation/Measurement	Total Volume (gal)
			Visual observation	Free Oil (visual sheen)

Notes:

¹ Locations are identified in Figure 1, Appendix D.

bbl/hr = barrels per hour

BOD₅ = 5-day biochemical oxygen demand

BOP = blowout preventer

gal = gallons

mgd = millions of gallons per day

MSD = marine sanitation device

OWS = oil/water separator

SPP = suspended particulate phase

TSS = total suspended solids

WET = whole effluent toxicity

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 34 of 174
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2.4.2 Sampling, Measurement, and Observation Frequencies

This section summarizes the procedures for ensuring compliance with the required sampling, measurement, and observation frequencies specified in the General Permit. Frequencies of general tasks related to the operational discharge compliance sampling program are summarized in Table 2-7.

Compliance monitoring requirements and sampling tasks for each discharge are presented in the following sections. All sampling related activities shall be conducted in accordance with this QAPP and the applicable SOPs and LWIs.

2.4.2.1 Daily Tasks

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Attend project health and safety meetings and project planning meetings and provide input and communication as it relates to sampling requirements;
- Maintain and document the condition of the sample storage refrigerator in accordance with the procedures outlined in this QAPP and M-I SWACO SOPs 1005 and 1006; and
- Provide daily activities report to the Drilling Foreman and the M-I SWACO Compliance Supervisor.

2.4.2.2 Weekly Tasks

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a weekly basis:

- Inspect and document the current inventory of sampling equipment, supplies, and containers in accordance procedures outlined in this QAPP and M-I SWACO SOP 1006; and
- Request additional materials as necessary.

2.4.2.3 Monthly Tasks

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Estimate monthly discharge flow volumes from daily measurements in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006 for all discharges; and
- Provide a monthly discharge flow volume report to the Drilling Foreman and M-I SWACO Compliance Supervisor detailing all discharges performed during the month, including daily discharge volume measurements.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 35 of 174
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**Table 2-7 Summary of Compliance Sampling, Measurement, and Observation
Frequencies and Related SOPs**

Frequency	Task	M-I SWACO SOP
Daily	Attend HSE and project planning meetings	N/A
	Maintain sample refrigerator	1005, 1006
	Daily activity report	N/A
Weekly	Sampling supply inventory	1006
Monthly	Estimate monthly discharge flow volumes	1006
	Monthly discharge flow volume report	N/A

Notes:

HSE = Health, Safety, and Environment

SOP = standard operating procedure

2.4.3 Compliance Sampling Requirements for Each Operational Discharge

Compliance activities include the collection of samples for analysis at the onboard laboratory and collection of samples for shipment to the subcontract analytical laboratory. Environmental samples will be collected using methods selected to ensure that project DQOs are met. SOPs and LWIs that outline the procedures to be followed for the collection and analysis of environmental samples are included as an attachment to this QAPP. These SOPs and LWIs ensure that project personnel collect representative samples in a consistent manner for all required sampling matrices and locations, that contamination is not introduced during collection, and that the sample volumes are properly preserved in order to meet project objectives and analytical method requirements.

The following sections describe the samples to be collected for each discharge to support compliance with this QAPP and the General Permit. For each discharge, the following information is presented: sampling tasks and frequency; the type and matrix of samples to be collected; analytical methods; required volume of sample; QC samples and frequency; and sample containers, preservation, and holding times.

2.4.3.1 Effluent Toxicity Testing

As part of the Phase II Assessment of the EMP, effluent toxicity testing will be conducted during exploration drilling activities. Toxicity analysis of Discharges 002 (deck drainage), 005 (desalination unit wastes), 007 (boiler blowdown), 008 (fire control system test water), 009 (non-contact cooling water), and 011 (bilge water) is required for monitoring of discharges under the General Permit.

The effluent samples will be collected from the discharge stream after the last treatment on the drilling rig and before the discharge stream enters the receiving waters. For discharges that require toxicity screening, a split of each sample will be collected for toxicity testing and operational discharge compliance analyses. Split samples are two or more representative portions taken from one sample in the field. To ensure that split samples are representative, the volume of sample collected must equal the total volume required for all of the laboratory analyses. For example, approximately 65 L of effluent must be collected and split for a discharge of deck drainage that requires initial toxicity screening (2L), WET testing (60 L), TAH (0.12 L), TAqH (2 L), static sheen (0.5 L), and pH (0.1 L) analyses.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 36 of 174
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Effluent toxicity testing as required under the General Permit will consist of an initial toxicity screening with 100% effluent at four different time periods selected to reflect discharge practices and operational processes. If the initial toxicity screen indicates the effluent sample may cause adverse biological impacts as defined by the toxicity testing threshold limits established for this program, then whole effluent toxicity (WET) testing is required. In addition, if discharge limits are exceeded as specified by 10,000 gallons in a 24 hour period and if chemicals are added to the system, then WET testing will also be initiated.

The threshold limits established for this program are based on the initial toxicity screening test using echinoderm fertilization success. This test has been demonstrated to have a detectable significant criteria ranging from 15.5% to 25% for various laboratories (Carr et al. 1996, USGS 1998, and Porebski et al. 1999). For this program, the initial toxicity screening thresholds include two criteria, which must both be met to indicate a positive toxicity result:

- 1) Percent fertilization has to be >70%.
- 2) A statistically significant difference between the control fertilization test and the 100% effluent and:
- 3) At least a 20% decline in fertilization compared to the corrected- control response.

For example, if the control percent fertilization was 80%, then the effluent response *must* be statistically significantly different from the control and have exhibited a greater than 25% difference in percent fertilization.

For discharges with a limited discharge stream, an adequate volume for each effluent sample will be collected to conduct the rapid screening test and WET testing, if triggered (2 L for rapid screen test and 60 L for three WET 7-day chronic assays). For all other discharges with a more continuous discharge stream, only 2 L will be collected for the rapid screening test; if the results of the rapid screening test indicate additional testing is required, then an additional 60 L will be collected for WET testing. WET testing samples will require the collection of three 10-L effluent samples on an every-other-day basis in order to provide test solution for initiation and renewals. Effluent samples will be collected for toxicity testing in accordance with the NewFields *Collection of Effluent Samples for Biological Testing Memorandum* dated 20 May 2013 (Appendix A).

Testing should be initiated on samples within 36 hours of sample collection, but must not exceed 72 hours as prescribed in the General Permit and method guidance. Effluent samples used for test solution renewals on the WET 7-day chronic tests (days 1-6) may be used up to 48-hours after the initial use (test initiation) (USEPA 2002). This guidance indicates that samples may be used for test solution renewals at up to 120 hours from the time of collection. Table 2-8 summarizes these holding times.

This sampling strategy was developed by the USEPA in order to capture a representative sample of a continuous discharge (such as sewage treatment plant) over a weeklong period with the intent of capturing any temporal differences in a discharge waste stream (USEPA 2002). In some cases, the collection of multiple samples from a single waste stream may not be feasible due to sporadic / non-continuous discharges. In these cases it may be acceptable to collect a single sample containing sufficient effluent volume to fulfill the WET requirements for the longer duration tests (7 days of testing which includes fresh effluent at test initiation and each of three renewals). This practice has been used to assess

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 37 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

the chronic toxicity of discrete discharge events such as storm water runoff or de-icing activities, where renewal samples are not able to be collected beyond the time period of the event in question. This approach is intended for use for boiler blowdown due to the infrequent discharge and limited volume of this waste stream.

Table 2-8 Effluent Sample Holding Times for Toxicity Testing

Holding Time for Test Initiation	Sample Aging for Use as Test Solution Renewal (During Test)
0 – 36 hours (recommended) 0 – 72 hours (allowed maximum)	0 – 84 hours (recommended) 0 – 120 hours (allowed maximum)

Note:

Holding times are from time of sample collection.

All toxicity testing will be conducted at the NewFields Port Gamble Environmental Laboratory located in Port Gamble, Washington. In order to meet holding times for testing, effluent sample collection for an applicable discharge event will be coordinated with helicopter transport and priority air freight shipping from Barrow, Alaska.

An example scenario and timeline for effluent sample collection and shipment is provided below. The timeline allows for minor delays in transport. Alaska Airlines has ~20 flights each day from Anchorage to Seattle. Departure of samples from Anchorage can occur aboard an earlier or slightly later flight to meet the 36 hour holding time (initiate test by 2000 on second day).

0800-1200	Effluent samples are collected during the morning of the applicable discharge event.
1200-1300	All samples are packed on ice in coolers and CoC procedures are initiated as described in this QAPP.
1300-1400	Samples are transported in the afternoon by helicopter to Alaska Air Cargo GoldStreak® in Barrow, Alaska.
1843-2035	Samples are transported by cargo only or a cargo/passenger aircraft (cargo and passengers) in the early evening to Anchorage, Alaska.
0150-0615	Samples are transported by cargo only, combination of cargo and passenger, or passenger aircraft in the early morning to Seattle, Washington. Alaska Air Cargo GoldStreak® known shipper status allows transport on passenger aircraft for packages less than 100 pounds.
0900-1200	Samples are transported by courier to NewFields Port Gamble Environmental Laboratory in the morning for sample log-in and test initiation by the afternoon.

2.4.3.2 Compliance Sampling for Water-Based Drilling Fluids and Drill Cuttings (Discharge 001)

Prior to drilling each well, the M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks:

- Collect and document a sample of stock barite for analysis of cadmium and mercury in accordance with the procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2009.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 38 of 174
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Immediately transfer the stock barite sample to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.

- Stock barite will be sampled once per well, unless the same supply of barite is used for subsequent wells. In this case, the previous analysis may be reported. If a new supply of barite is obtained, this must be sampled and analyzed for cadmium and mercury prior to drilling a well.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks while discharging water-based drilling fluids and cuttings:

- Estimate the volume of fluids and cuttings discharged hourly by calculating the hourly discharge rate in bbl/hr, and ensure that the depth-dependent discharge rate in Table 10-3 is not exceeded. The Drilling Foreman and M-I SWACO Compliance Supervisor will be notified when the discharge rate exceeds 75% of the maximum allowable hourly discharge rate and there is potential for that rate to be exceeded.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks on a daily basis:

- Document the flow volumes from all discharge flow meters and waste volumes in bulk discharge holding tanks aboard the drillship in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006. The total daily volumes of drilling fluids and drill cuttings will be recorded and reported in the End of Well Report, and total volume discharge per calendar day will be recorded daily and reported monthly in the Discharge Monitoring Report (DMR).
- Perform and document visible sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.
- Collect samples and document results for static sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3004. As soon as practicable, perform static sheen analysis.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks on a weekly basis:

- Collect and document a water-based drilling fluids and cuttings sample SPP toxicity in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006, 2001, and 2002. Immediately transfer the SPP toxicity sample to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003. Retain one SPP toxicity sample container in the sample refrigerator until acceptable results are received for the sample transported to the analytical laboratory. If problems occur with the original SPP toxicity sample transported to the analytical laboratory that will invalidate the results, package and transport the remaining sample to the analytical laboratory for analysis.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 39 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Once per well, the M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. Immediately deliver pH samples to the shipboard laboratory for analysis.
- Collect and document a water-based drilling fluid sample for TAH and TAqH in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006, 2001, and 2008. Immediately transfer the samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003. Samples must be collected at the same time as the SPP toxicity sample, to the extent practical (see end of well tasks below).
- Collect and document a water-based drilling fluid sample for diesel oil (fingerprint) analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006, 2001, and 2008. Immediately transfer the samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.
- When total depth of the well (end of well) has been reached, the M-I SWACO Compliance Specialist is responsible for performing the following tasks: Collect and document a water-based drilling fluids and cuttings sample for SPP toxicity in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006, 2001, and 2002. Immediately transfer the sample to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003. Retain one SPP toxicity sample container in the sample refrigerator until acceptable results are received for the sample transported to the analytical laboratory. If problems occur with the original SPP toxicity sample transported to the analytical laboratory that will invalidate the results, package and transport the remaining sample to the analytical laboratory for analysis.
- In support of the EMP, two samples of used water-based mud (WBM) and two samples of drill cuttings will be collected during three intervals of the drilling in Phase II of the monitoring program (Table 3-4) for a total of 12 samples. Drilling-mud compositions and monitoring records will be obtained from the drill-rig supervisor to the degree possible. The three drilling phases targeted for this sampling include 1) largest casing interval (beyond the top-hole), 2) penetration into the hydrocarbon zone, and 3) bulk-mud discharge (if this occurs). The WBM and drill cuttings will be collected by personnel on the Shell drilling rig (e.g., Compliance Specialist), placed in clean glass jars, and provided to the Field Leader for handling according to Section 3.5.2.

Table 2-9 summarizes the drilling fluid and effluent monitoring tasks and frequencies, and Table 2-10 summarizes the analytical samples that will be collected for Discharge 001, Water-Based Drilling Fluids and Drill Cuttings.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 40 of 174
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**Table 2-9 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 001**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
	Visual sheen tests	1006, 3005
	Static sheen tests	1006, 2001, 3004
Prior to drilling	Stock barite metals sample	1006, 2001, 2003, 2009
Weekly	SPP toxicity sample	1006, 2001, 2002, 2003, Section 2.4.3
Once per well	pH samples of drilling fluid	1006, 2001, 2012
	TAH/TAqH samples of drilling fluid	1006, 2001, 2003, 2008
	Diesel fingerprint sample of aqueous drilling fluid	1006, 2001, 2003, 2008
End of well	SPP toxicity sample	1006, 2001, 2002, 2003, Section 2.4.3
During discharge	Hourly volume measurements and flow rate estimates for discharge of water-based drilling fluids/drill cuttings	1006

Notes:

HSE = Health, Safety, and Environment
SOP = standard operating procedure
SPP = suspended particulate phase
TAH = total aromatic hydrocarbons
TAqH = total aqueous hydrocarbons

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 41 of 174
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Table 2-10 Analytical Sampling for Water-Based Drilling Fluids and Drill Cuttings (Discharge 001)

Type of sample	Matrix	Parameter	Analytical Method	Permit Limit/ Water Quality Standard	Required Volume	Sample Container	Preservative	Holding Time	Sampling Frequency
Stock barite	Solid	Mercury	SW6020	1 mg/kg	10 g	(1) 4-oz glass wide-mouth jar w/TLC	Cool 4±2°C	28 days	Prior to drilling, or new supply of barite
		Cadmium		3 mg/kg	10 g	(1) 4-oz glass wide-mouth jar w/TLC	Cool 4±2°C	180 days	Once per well
Mud & cuttings from shale shakers	Aqueous	Suspended particulate phase (SPP) toxicity	40 CFR 435, App. 2 to Subpart A (E1619)	96-hr LC ₅₀ > 30,000 ppm	1 L	(1) 1-gal (4L) LDPE jar	0 to 4°C	90 days	Weekly and End of well
		TAH/TAqH ¹	E602+xylenes by E624	Report (µg/L)	40 mL	(3) 40-mL VOA vials w/TLS	Cool 4±2°C, HCl to pH<2	14 days	Once per well
			E625 SIM	Report (µg/L)	1 L	(2) 1-L amber glass jars w/TLC	Cool 4±2°C	7 days to extraction, 40 days to analysis	
	Aqueous	Diesel fingerprint	SW8015C	No discharge	10 mL	(2) 40-mL VOA vials w/TLS	Cool 4±2°C	7 days to extraction, 40 days to analysis	Once per well, or if static sheen test fails
	Oil				10 mL	(2) 40-mL VOA vials w/TLS			

Notes:

All samples will be collected as grab samples.

¹ Sample must be collected at the same time as the SPP toxicity test, to the extent practicable, and at the end of well.

µg/L = micrograms per liter

mg/kg = milligrams per kilogram

mL = milliliter

L = liter

HCl = hydrochloric acid

LDPE = low-density polyethylene

OWS = oil/water separator

SPP = suspended particulate phase

TAH = total aromatic hydrocarbons

TAqH = total aqueous hydrocarbons

TLC = Teflon-lined cap

TLS = Teflon-lined septa

VOA = volatile organic analysis

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 42 of 174
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2.4.3.3 Compliance Sampling for Deck Drainage (Discharge 002)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect samples and document samples for pH analysis in accordance with QAPP procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. As soon as practicable, transport pH samples to the shipboard laboratory for analysis.

The M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks four times per well:

- Four times per well, at intervals designated to be representative of the discharge's toxicity, a sample will be collected for initial toxicity screening. Each sample will be collected at a time period selected to reflect discharge processes and operational processes. Collect and document initial toxicity screening samples in accordance with the procedures outlined in Section 2.4.3 of this QAPP.
- WET testing will be required if either of the following occurs: 1) Initial rapid toxicity screening threshold criteria are exceeded OR 2) discharge exceeds 10,000 gallons during any 24-hr period and chemicals are added to the system. If WET testing is required, collect and document three samples from the OWS effluent on an every-other-day basis in accordance with the procedures outlined in Section 2.4.3 of this QAPP. Immediately transfer the samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks once per discharge event:

- Collect and document samples from the OWS effluent for TAH and TAqH in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006, 2001, and 2008. Immediately transfer the samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.
- Perform and document visible sheen test in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.
- Document the flow volumes from the OWS effluent flow meter in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006. Additionally, the volume discharged directly overboard will be estimated and recorded. The total volume in gallons will be reported monthly.
- Collect samples for static sheen tests from OWS effluent and document results in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3004. Immediately deliver samples to the shipboard laboratory for analysis.

Table 2-11 summarizes the effluent monitoring tasks and frequencies, and Table 2-12 summarizes the analytical samples that will be collected for Discharge 002, Deck Drainage.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 43 of 174
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**Table 2-11 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 002**

Frequency	Task	M-I SWACO SOP
Once per discharge event	Document discharge flow volumes	1006
	TAH/TAqH samples of deck drainage	1006, 2001, 2003, 2008
	Visual sheen test	1006, 3005
	Static sheen test	1006, 2001, 3004
Monthly	pH sample	1006, 2001, 2012
Four times per well	Initial effluent toxicity screening	1006, 2001, NewFields Memo 5/20/13
	WET testing (if required)	1006, 2001, Section 2.4.3

Notes:

SOP = standard operating procedure
TAH = total aromatic hydrocarbons
TAqH = total aqueous hydrocarbons
WET = whole effluent toxicity

Table 2-12 Analytical Sampling for Deck Drainage (Discharge 002)

Type of sample	Matrix	Parameter	Analytical Method	Effluent Limit/ Water Quality Standard	Required Volume	Sample Container	Preservative	Holding Time	Sampling Frequency
OWS Effluent	Aqueous	TAH/TAqH	E602+xylenes by E624	Report (µg/L)	40 mL	(3) 40-mL VOA vials w/TLS	Cool 4±2°C, HCl to pH<2	14 days	Once per discharge event
			E625 SIM	Report (µg/L)	1 L	(2) 1-L amber glass jars w/TLC	Cool 4±2°C	7 days to extraction, 40 days to analysis	
		Initial toxicity screening	EPA/600/R-95-136 (TOX045A.01)	Report – Test is statistically significantly different from control AND there is >20% decline in fertilization relative to control	1-L	(1) 1-L LDPE bottle	0 to 4°C	90 days	Four times per well
		WET ²	EPA/600/R-95-136 (Topsmelt Chronic 7d Survival and Growth Test) ¹ or EPA/821-R-02-014 (Menidia Chronic 7d Survival and Growth Test) ¹	Report	30-L	(3) 10-L LDPE cubitainers	Cool 4±2°C	36 hours (Max 72 hrs)	Upon failure of toxicity screening criteria, OR Once per well if discharge exceeds 10,000 gal and chemicals are added to the system
			EPA/821-R-02-014 (Mysid Chronic 7d Survival, Growth, and Fecundity Test) ¹		30-L	(3) 10-L LDPE cubitainers			

AKG-28-8100– Noble Discoverer

Revision 0, Effective Date May 2013

Page 45 of 174

CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.

*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

Type of sample	Matrix	Parameter	Analytical Method	Effluent Limit/ Water Quality Standard	Required Volume	Sample Container	Preservative	Holding Time	Sampling Frequency
OWS Effluent	Aqueous	WET ²	EPA/600/R-95-136 (Echinoderm Larval Development Test)		1-L	(1) 1-L LDPE bottle			

Notes:

All samples collected as grab samples.

¹ Samples for these tests should be provided as one, 10-L sample on an every-other-day basis. If this sample strategy is not feasible, a single sample of 30 L may be provided at one time.

² Samples for WET testing may be collected in larger containers (up to 20-L LDPE cubitainers or different combination thereof) to facilitate sufficient volume to conduct all three tests.

µg/L = micrograms per liter

mL = milliliter

L = liter

EPA = U.S. Environmental Protection Agency

HCl = hydrochloric acid

LDPE = low-density polyethylene

OWS = oil/water separator

TAH = total aromatic hydrocarbons

TAQH = total aqueous hydrocarbons

TLC = Teflon-lined cap

TLS = Teflon-lined septa

VOA = volatile organic analysis

WET = whole effluent toxicity

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 46 of 174
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2.4.3.4 Compliance Sampling for Sanitary Wastes (Discharge 003)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Document the sanitary waste flow volume from the effluent flow meter in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.
- Perform and document visual assessments for floating solids, sheen, debris, sludge, foam, deposits, scum, or other residues from discharges of sanitary wastes in accordance with QAPP Section 3.0 and M-I SWACO SOP 1006.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a weekly basis:

- Collect and document treated sanitary waste samples for pH, BOD₅, TSS, fecal coliform (FC) bacteria, and total residual chlorine (if used) in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006, 2001, 2010, 2011, 2012, 2013, and 2014. Immediately deliver pH and total residual chlorine samples to the shipboard laboratory for analysis. Immediately transfer BOD₅, TSS, and FC samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.

Table 2-13 summarizes the effluent monitoring tasks and frequencies, and Table 2-14 summarizes the analytical samples that will be collected for Discharge 003, Sanitary Wastes.

**Table 2-13 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 003**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
	Visual assessments of receiving waters	1006, 3005
	Visual sheen tests	1006, 3005
Weekly	pH sample	1006, 2001, 2012
	BOD ₅ , TSS, Total residual chlorine samples	1006, 2001, 2003, 2010, 2013, 2014
	Fecal coliform bacteria sample	1006, 2001, 2003, 2011

Notes:

BOD₅ = 5-day biochemical oxygen demand
SOP = standard operating procedure
TSS = total suspended solids
WET = whole effluent toxicity

Table 2-14 Analytical Sampling for Sanitary Wastes (Discharge 003)

Type of sample	Matrix	Parameter	Preparation and Analysis Method	Effluent Limit/ Water Quality Standard	Required Volume	Sample Container	Preservative	Holding Time	Sampling Frequency
Treatment System Effluent	Aqueous	BOD ₅	SM5210-B	30 mg/L (Monthly average); 60 mg/L (Daily limit)	1 L	(1) 1-L poly bottle	Cool 4±2°C	48 hours	Weekly
		TSS	SM2540-D	30 mg/L (Monthly average); 60 mg/L (Daily limit)	1 L	(1) 1-L poly bottle	Cool 4±2°C	7 days	
		Fecal coliform bacteria	SM9222-D	100 colonies/100 mL (Monthly average); 200 colonies/100 mL (Daily Limit)	100 mL	(1) 125-mL sterile poly container w/ Na ₂ S ₂ O ₃	Cool 4±2°C, Na ₂ SO ₃	6 hours	

Notes:

All samples will be collected as grab samples.

L = liter

mg/L = milligrams per liter

mL = milliliter

BOD₅ = 5-day biochemical oxygen demand

Na₂S₂O₃ = sodium thiosulfate

TSS = total suspended solids

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 48 of 174
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2.4.3.5 Compliance Sampling for Domestic Wastes (Discharge 004)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Document the domestic waste flow volume in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.
- Perform and document visual assessments for floating solids, garbage, or foam from discharges of domestic wastes in accordance with QAPP Section 3.0 and M-I SWACO SOP 1006.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. Immediately deliver pH samples to the shipboard laboratory for analysis.

Table 2-15 summarizes the effluent monitoring tasks and frequencies for Discharge 004, Domestic Wastes.

**Table 2-15 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 004**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
	Visual assessments of receiving waters	1006, 3005
Weekly	pH sample	1006, 2001, 2012

Notes:

SOP = standard operating procedure

2.4.3.6 Compliance Sampling for Desalination Unit Wastes (Discharge 005)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Document the estimated flow volume in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.

The M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks four times per well:

- Four times per well, at intervals designated to be representative of the discharge's toxicity, a sample will be collected for initial toxicity screening. Each sample will be collected at a time period selected to reflect discharge processes and operational processes. Collect and document initial toxicity screening samples in accordance with the procedures outlined in Section 2.4.3 of this QAPP.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 49 of 174
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- WET testing will be required if either of the following occurs: 1) Initial rapid toxicity screening threshold criteria are exceeded OR 2) discharge exceeds 10,000 gallons during any 24-hr period and chemicals are added to the system. If WET testing is required, collect and document three samples from the OWS effluent on an every-other-day basis in accordance with the procedures outlined in Section 2.4.3 of this QAPP. Immediately transfer the samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks per discharge event:

- Perform and document visual sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.
- If visual sheen tests cannot be performed, collect and document samples for static sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3004.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. As soon as practicable, deliver pH samples to the shipboard laboratory for analysis.

Table 2-16 summarizes the effluent monitoring tasks and frequencies for Discharge 005, Desalination Unit Wastes.

**Table 2-16 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 005**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
Four times per well	Effluent toxicity screening	1006, 2001, NewFields Memo 5/20/13
	WET testing (if required)	1006, 2001, NewFields Memo 5/20/13
Monthly	pH sample	1006, 2001, 2012
Discharge event	Visual sheen test	1006, 2001, 2003, 2008
	Static sheen test (if required)	1006, 2001, 3004

Notes:

SOP = standard operating procedure

WET = whole effluent toxicity

2.4.3.7 Compliance Sampling for Blowout Preventer Fluid (Discharge 006)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 50 of 174
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- Document the estimated flow volume in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks per discharge event:

- Perform and document visual sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.
- If visual sheen tests cannot be performed, collect and document samples for static sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3004.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. As soon as practicable, deliver pH samples to the shipboard laboratory for analysis.

Table 2-17 summarizes the effluent monitoring tasks and frequencies for Discharge 006, Blowout Preventer Fluid.

**Table 2-17 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 006**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
Monthly	pH sample	1006, 2001, 2012
Discharge event	Visual sheen test	1006, 2001, 2003, 2008
	Static sheen test (if required)	1006, 2001, 3004

Notes:

SOP = standard operating procedure

2.4.3.8 Compliance Sampling for Boiler Blowdown (Discharge 007)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Document the estimated flow volume in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.

The M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks four times per well:

- If possible four times per well, at intervals designated to be representative of the discharge's toxicity, a sample will be collected for initial toxicity screening. Each sample will be collected at a time period selected to reflect discharge processes and operational processes. Collect and document initial toxicity screening samples in accordance with the procedures outlined in Section

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 51 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

2.4.3 of this QAPP. Due to the infrequency of discharge and limited volume of water produced, it is unlikely that this screening will be able to be performed four times per well.

- WET testing will be required if either of the following occurs: 1) Initial rapid toxicity screening threshold criteria are exceeded OR 2) discharge exceeds 10,000 gallons during any 24-hr period and chemicals are added to the system. If WET testing is required, collect and document three samples from the OWS effluent on an every-other-day basis in accordance with the procedures outlined in Section 2.4.3 of this QAPP. Immediately transfer the samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks per discharge event:

- Perform and document visual sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.
- If visual sheen tests cannot be performed, collect and document samples for static sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3004.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. As soon as practicable, deliver pH samples to the shipboard laboratory for analysis.

Table 2-18 summarizes the effluent monitoring tasks and frequencies for Discharge 007, Boiler Blowdown.

**Table 2-18 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 007**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
Four times per well	Effluent toxicity screening	1006, 2001, NewFields Memo 5/20/13
	WET testing (if required)	1006, 2001, NewFields Memo 5/20/13
Monthly	pH sample	1006, 2001, 2012
Discharge event	Visual sheen test	1006, 2001, 2003, 2008
	Static sheen test (if required)	1006, 2001, 3004

Notes:

SOP = standard operating procedure

WET = whole effluent toxicity

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 52 of 174
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2.4.3.9 Compliance Sampling for Fire Control System Test Water (Discharge 008)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Estimate flow volume in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.

The M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks four times per well:

- Four times per well, at intervals designated to be representative of the discharge's toxicity, a sample will be collected for initial toxicity screening. Each sample will be collected at a time period selected to reflect discharge processes and operational processes. Collect and document initial toxicity screening samples in accordance with the procedures outlined in Section 2.4.3 of this QAPP.
- WET testing will be required if either of the following occurs: 1) Initial rapid toxicity screening threshold criteria are exceeded OR 2) discharge exceeds 10,000 gallons during any 24-hr period and chemicals are added to the system. If WET testing is required, collect and document three samples from the OWS effluent on an every-other-day basis in accordance with the procedures outlined in Section 2.4.3 of this QAPP. Immediately transfer the samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks per discharge event:

- Perform and document visual sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.
- If visual sheen tests cannot be performed, collect and document samples for static sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3004.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. Immediately deliver pH samples to the shipboard laboratory for analysis.

Table 2-19 summarizes the effluent monitoring tasks and frequencies for Discharge 008, Fire Control System Test Water.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 53 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

**Table 2-19 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 008**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
Four times per well	Effluent toxicity screening	1006, 2001, NewFields Memo 5/20/13
	WET testing (if required)	1006, 2001, NewFields Memo 5/20/13
Monthly	pH sample	1006, 2001, 2012
Discharge event	Visual sheen test	1006, 2001, 2003, 2008
	Static sheen test (if required)	1006, 2001, 3004

Notes:

SOP = standard operating procedure

WET = whole effluent toxicity

2.4.3.10 Compliance Sampling for Non-contact Cooling Water (Discharge 009)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis for each of the non-contact cooling water discharges:

- Document the flow volume from the effluent flow meters in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.
- Perform and document visual sheen tests for each outfall in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.
- Temperature will be monitored continuously and documented for non-contact cooling water (009) in accordance with procedures outlined in this QAPP and M-I SWACO LWI-001.

The M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks four times per well:

- Four times per well, at intervals designated to be representative of the discharge's toxicity, a sample will be collected for initial toxicity screening. Each sample will be collected at a time period selected to reflect discharge processes and operational processes. Collect and document initial toxicity screening samples in accordance with the procedures outlined in Section 2.4.3 of this QAPP.
- WET testing will be required if either of the following occurs: 1) Initial rapid toxicity screening threshold criteria are exceeded OR 2) discharge exceeds 10,000 gallons during any 24-hr period and chemicals are added to the system. If WET testing is required, collect and document three samples from the OWS effluent on an every-other-day basis in accordance with the procedures outlined in Section 2.4.3 of this QAPP. Immediately transfer the samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 54 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. As soon as practicable, deliver pH samples to the shipboard laboratory for analysis.

Table 2-20 summarizes the effluent monitoring tasks and frequencies for Discharge 009, Non-contact Cooling Water.

Table 2-20 Summary of Compliance Sampling, Measurement, and Observation Frequencies for Discharge 009

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
	Visual sheen tests	1006, 3005
	Temperature monitoring of non-contact cooling water	1006, LWI-001
Four times per well	Effluent toxicity screening	1006, 2001, NewFields Memo 5/20/13
	WET testing (if required)	1006, 2001, NewFields Memo 5/20/13
Monthly	pH sample	1006, 2001, 2012

Notes:

SOP = standard operating procedure

WET = whole effluent toxicity

2.4.3.11 Compliance Sampling for Uncontaminated Ballast Water (Discharge 010)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Document the estimated flow volume in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks per discharge event:

- Perform and document visual sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.
- If visual sheen tests cannot be performed, collect and document samples for static sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3004.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. As soon as practicable, deliver pH samples to the shipboard laboratory for analysis.

Table 2-21 summarizes the effluent monitoring tasks and frequencies for Discharge 010, Uncontaminated Ballast Water.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 55 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

**Table 2-21 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 010**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
Monthly	pH sample	1006, 2001, 2012
Discharge event	Visual sheen test	1006, 2001, 2003, 2008
	Static sheen test (if required)	1006, 2001, 3004

Notes:

SOP = standard operating procedure

WET = whole effluent toxicity

2.4.3.12 Compliance Sampling for Bilge Water (Discharge 011)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Document the flow volume for discharges from the effluent flow meters in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.

The M-I SWACO Compliance Specialist is responsible for performing the following sampling tasks four times per well:

- Four times per well, at intervals designated to be representative of the discharge's toxicity, a sample will be collected for initial toxicity screening. Each sample will be collected at a time period selected to reflect discharge processes and operational processes. Collect and document initial toxicity screening samples in accordance with the procedures outlined in Section 2.4.3 of this QAPP.
- WET testing will be required if either of the following occurs: 1) Initial rapid toxicity screening threshold criteria are exceeded OR 2) discharge exceeds 10,000 gallons during any 24-hr period and chemicals are added to the system. If WET testing is required, collect and document three samples from the OWS effluent on an every-other-day basis in accordance with the procedures outlined in Section 2.4.3 of this QAPP. Immediately transfer the samples to the sample refrigerator for storage awaiting packaging for transportation to the analytical laboratory. Package samples for transport to the analytical laboratory in accordance with procedures outlined in this QAPP and M-I SWACO SOP 2003.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks per discharge event:

- Collect and document a sample for static sheen test for discharge of bilge water (011) that has been processed through the OWS in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3004.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 56 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. As soon as practicable, deliver pH samples to the shipboard laboratory for analysis.

Table 2-22 summarizes the effluent monitoring tasks and frequencies for Discharge 011, Bilge Water.

**Table 2-22 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 011**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
	Visual sheen tests	1006, 3005
Four times per well	Effluent toxicity screening	1006, 2001, NewFields Memo 5/20/13
	WET testing (if required)	1006, 2001, NewFields Memo 5/20/13
Monthly	pH sample	1006, 2001, 2012
Discharge event	Static sheen test	1006, 2001, 3004

Notes:

SOP = standard operating procedure

WET = whole effluent toxicity

2.4.3.13 Compliance Sampling for Excess Cement Slurry (Discharge 012)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Document the estimated flow volume in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks per discharge event:

- Perform and document visual sheen tests in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a monthly basis:

- Collect and document samples for pH analysis in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 2012. As soon as practicable, deliver pH samples to the shipboard laboratory for analysis.

Table 2-23 summarizes the effluent monitoring tasks and frequencies for Discharge 012, Excess Cement Slurry.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 57 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

**Table 2-23 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 012**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
Monthly	pH sample	1006, 2001, 2012
Discharge event	Visual sheen test	1006, 2001, 3004

Notes:

SOP = standard operating procedure

2.4.3.14 Compliance Sampling for Muds, Cuttings, and Cement at the Seafloor (Discharge 013)

During active drilling operations, the M-I SWACO Compliance Specialist is responsible for performing the following tasks on a daily basis:

- Document the estimated flow volume in accordance with procedures outlined in this QAPP and M-I SWACO SOP 1006.
- Perform and document visual sheen tests for each outfall in accordance with procedures outlined in this QAPP and M-I SWACO SOPs 1006 and 3005.

Table 2-24 summarizes the effluent monitoring tasks and frequencies for Discharge 013, Muds, Cuttings, and Cement at the Seafloor.

**Table 2-24 Summary of Compliance Sampling, Measurement, and Observation
Frequencies for Discharge 013**

Frequency	Task	M-I SWACO SOP
Daily	Document discharge flows and waste volumes	1006
	Visual sheen tests	1006, 3005

Notes:

SOP = standard operating procedure

2.4.4 Field SOPs

2.4.4.1 Purpose and General Provisions

The SOPs and LWIs are formal, revision-controlled documents that:

- Define the methods used in the performance of tasks having an effect on the quality of data, findings, or conclusions;
- Provide standard methods for execution and documentation of work, so as to maximize uniformity and reliability of products; and
- Facilitate coordination among individuals performing separate but interdependent tasks. SOPs and/or LWIs are generated through a cooperative effort among operations and QA personnel.

QA personnel coordinate their development, which involves an iterative process of review and revision until they are satisfactory to both QA and the technical reviewers.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 58 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

2.4.4.2 SOP and LWI Revisions

As a SOP or LWI is revised, the revision number is incremented and the revised SOP released to the distribution list. SOP and LWI revisions shall be processed through the M-I SWACO Compliance Supervisor or appropriate QA staff. SOP revisions may be necessitated by regulatory requirements, technological advancements, or other causes.

Dated acceptance signatures signify approval of the revisions. One technical reviewer and the M-I SWACO Compliance Supervisor or designee shall approve revisions of SOPs and LWIs. Once formally accepted, the revised document replaces the previous version and is distributed to SOP holders with instructions as to which document(s) it replaces.

The M-I SWACO Compliance Supervisor distributes SOPs and LWIs to technical staff and maintains distribution lists to confirm revisions. New SOPs and LWIs are distributed to responsible individuals.

2.4.4.3 Sampling SOPs and LWIs

Sampling SOPs and LWIs shall be developed, approved, and distributed to Compliance Specialists. The SOP and/or LWI shall address, as applicable, the following elements:

- The objectives of the General Permit;
- A description of the overall sampling scheme (see below);
- The number and location of sampling points;
- The number and location of control samples;
- Requirements for QC samples such as blanks, duplicates/replicates, matrix spikes, etc;
- The analyses to be performed (physical, chemical, toxicological, biological);
- The laboratory (or laboratories) that will perform the analyses;
- The analytical methods to be used;
- The number and size (weight or volume) of samples to be collected for each type of analysis;
- Sample collection methods, specifying sampling equipment or SOPs, where applicable;
- Field screening procedures and criteria; and
- Sample containerization, preservation, and transportation procedures.

The M-I SWACO Compliance Specialists and subcontract laboratories shall be notified of sampling program schedules in advance, so that personnel and physical resources can be scheduled to meet sample holding time limitations and other General Permit requirements.

M-I SWACO operational discharge sampling-related SOPs and LWIs are listed in Table 2-25. The SOPs and LWIs listed in these tables are also included in Appendix A to this QAPP.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 59 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

2.4.5 Analytical SOPs

NewFields drilling fluid and effluent toxicity testing SOPs are listed in Table 2-26 and included in Appendix A to this QAPP. Analytical SOPs for additional methods performed by subcontract laboratories are available upon request.

Table 2-25 Operational Discharge Compliance Sampling Related SOPs

M-I SWACO SOP Number	M-I SWACO SOP Title
1001	Qualification and Documentation of Computer Programs
1002	Traceability of Reagents, Standards, and Reference Materials
1003	Equipment Tracking
1004	Balance Calibration
1005	Laboratory Refrigerators
1006	Field Logs
1008	Demonstration of Capability
LWI-002	Chemical Inventory Management
2001	Chain-of-Custody (C-O-C) Procedures
2002	Sample Collection for Suspended Particulate Phase (SPP) Toxicity Test
2003	Packaging and Shipment of Samples
2004	Decontamination of Equipment
2008	Sample Collection for TAH and TAqH Analyses
2009	Sample Collection for Mercury and Cadmium in Stock Barite
2010	Sample Collection for Biochemical Oxygen Demand (BOD ₅) Analysis
2011	Sample Collection for Fecal Coliform Analysis
2012	Field Measurement of pH
2013	Field Measurement of Total Residual Chlorine
2014	Sample Collection for Total Suspended Solids (TSS) Analysis
LWI-001	Continuous Temperature Monitoring
3004	Free Oil by Static Sheen Method
3005	Visual Sheen Test Method

Note:

BOD₅ = biochemical oxygen demand

SOP = standard operating procedure

SPP = suspended particulate phase

TAH = total aromatic hydrocarbons

TAqH = total aqueous hydrocarbons

TSS = total suspended solids

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 60 of 174
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Table 2-26 Drilling Fluid and Effluent Toxicity Testing SOPs

NewFields SOP Number	NewFields SOP Title
Memo 5/20/2013	Collection of Effluent Samples for Biological Testing
TOX045.01	Sperm Cell Toxicity Screening Test Using Echinoderms (<i>Strongylocentrotus purpuratus</i> or <i>Dendraster excentricus</i>)
TOX002.03	7-Day Chronic Toxicity Study with <i>Atherinops affinis</i>
TOX012.04	7-Day Chronic Toxicity Study with <i>Menidia beryllina</i>
TOX014B.01	7-Day Chronic Toxicity Study with <i>Americamysis bahia</i> (<i>Mysidopsis bahia</i>)
TOX043.04	Chronic Toxicity Test Using Echinoderm Larvae (<i>Strongylocentrotus purpuratus</i> or <i>Dendraster excentricus</i>)
SED026.01	96-Hour Acute Suspended Particulate Phase (SPP) Toxicity Test with <i>Americamysis bahia</i> Using Drilling Fluid

Note:

SOP = standard operating procedure

SPP = suspended particulate phase

2.4.6 Sample Handling and Custody

2.4.6.1 Responsibilities

The Operations Manager/Drilling Superintendent, or designee, is responsible for verifying that a sampling SOP is prepared that conforms to the provisions of this chapter, while fulfilling General Permit objectives. The Compliance Supervisor is responsible for assembling or ordering onsite laboratory sampling kits. Subcontract laboratories are responsible for supplying sample containers for fixed laboratory analyses. Compliance Specialists are responsible for collecting the field and QC samples as described in this chapter and as required by the General Permit; and for adhering to the sample packaging, labeling, and documentation requirements of this chapter and associated SOPs. The M-I SWACO Compliance Specialist is responsible for collecting grab samples at a point representative of the discharge. The subcontract laboratory sample custodian is responsible for the proper inspection, login, and storage of incoming samples, as defined in the laboratory's SOPs.

2.4.6.2 Sample Containers, Preservation, and Storage

In general, samples will be collected for onsite laboratory analysis and subcontract laboratory analysis in containers as required by the analytical methods. Sample containers are provided by the laboratory and may be pre-cleaned and/or pre-preserved (if required by the analytical method).

The M-I SWACO Compliance Specialist will clean containers for static sheen and retort cuttings samples onsite following the procedures in SOP 2004 Decontamination of Equipment (Appendix A).

After collection, the samples are maintained at the required temperature (for most samples, 4±2°C) under CoC procedures until analysis or until they are shipped to a subcontract laboratory for analysis. For operational discharge compliance program samples, the samples should not be frozen. Procedures for packaging and shipping samples are outlined in M-I SWACO SOP 2003 Packaging and Shipment of Samples.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 61 of 174
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A summary of the analytical methods, sample containers, preservation, and holding times for samples that will be submitted to subcontract laboratories for analysis is included in Table 2-27.

Table 2-27 Sample Containers, Preservation, and Holding Times

Analyte/ Analyte Group	Method/SOP	Container(s) (number, size, & type per sample)	Preservation	Holding Time
SOLID MATRIX (BARITE)				
Mercury	SW6020	(1) 4 oz. wide-mouth glass jar w/TLC	Cool 4±2°C	28 days
Cadmium				180 days
OIL MATRIX				
Diesel fingerprint	SW8015C	(2) 40-mL VOA vials w/TLS	Cool 4±2°C	7 days to extraction, 40 days to analysis
AQUEOUS MATRIX				
TAH/TAqH ¹	E602+xylenes by E624	(3) 40-mL VOA vials w/TLS	Cool 4±2°C, HCl to pH<2	14 days
	E625 SIM	(2) 1-L amber glass jars w/TLC	Cool 4±2°C	7 days to extraction, 40 days to analysis
Diesel fingerprint	SW8015C	(2) 40-mL VOA vials w/TLS	Cool 4±2°C	7 days to extraction, 40 days to analysis
SPP toxicity	40 CFR 435, App. 2 to Subpart A (E1619)	(1) 1-gal (4L) LDPE jar	0 to 4°C	90 days
Initial toxicity screening	EPA/600/R-95-136 (Echinoderm Fertilization Test)	(1) 1-L LDPE bottle	Cool 4±2°C	36 hours (72 hours maximum)
WET ²	EPA/600/R-95-136 (Topsmelt Chronic 7d Survival and Growth Test) ¹ or EPA/821-R-02-014 (Menidia Chronic 7d Survival and Growth Test) ¹	(3) 10-L LDPE cubitainers	Cool 4±2°C	36 hours (72 hours maximum)
	EPA/821-R-02-014 (Mysid Chronic 7d Survival, Growth, and Fecundity Test) ¹	(3) 10-L LDPE cubitainers	Cool 4±2°C	36 hours (72 hours maximum)
	EPA/600/R-95-136 (Echinoderm Larval Development Test)	(1) 1-L LDPE bottle	Cool 4±2°C	36 hours (72 hours maximum)
	BOD ₅	SM5210-B	(1) 1-L poly bottle	Cool 4±2°C
TSS	SM2540-D	(1) 1-L poly bottle	Cool 4±2°C	7 days

Analyte/ Analyte Group	Method/SOP	Container(s) (number, size, & type per sample)	Preservation	Holding Time
Fecal coliform bacteria	SM9222-D	(1) 125-mL sterile poly container w/ Na ₂ S ₂ O ₃	Cool 4±2°C, Na ₂ SO ₃	6 hours

Note:

¹ Samples for these tests should be provided as one, 10-L sample on an every-other-day basis. If this sample strategy is not feasible, a single sample of 30 L may be provided at one time.

² Samples for WET testing may be collected in larger containers (up to 20-L LDPE cubitainers or different combination thereof) to facilitate sufficient volume to conduct all three tests.

BOD₅ = biochemical oxygen demand

HCl = hydrochloric acid

mL = milliliter

L = liter

Na₂S₂O₃ = sodium thiosulfate

SOP = standard operating procedure

SPP = suspended particulate phase

TAH = total aromatic hydrocarbons

TAQH = total aqueous hydrocarbons

TLC = Teflon-lined cap

TLS = Teflon-lined septa

TSS = total suspended solids

VOA = volatile organic analysis

WET = whole effluent toxicity

2.4.6.3 Sample Receipt

Sample receipt and CoC will be maintained at the subcontract laboratory in accordance with the procedures outlined in Section 1.8 of this QAPP. Drilling and effluent samples for toxicity testing require additional procedures to verify acceptability upon receipt at the laboratory.

Receipt of Drilling Fluid Samples for SPP Toxicity Analysis

Drilling fluid samples provided for biological testing must also meet the temperature requirements described above. The pH of the drilling fluid samples will be tested upon receipt. If the pH is less than 9, if black spots have appeared on the walls of the sample container, or if the mud sample has a foul odor, then the sample does not meet the method specific acceptability criteria for drilling fluids as specified in 40 CFR Part 435. If the drilling fluid does not meet the acceptability criteria for testing, the client will be notified and the decision to proceed will be evaluated. The drilling fluid should be used for testing within three months from the time of collection. Elutriate samples prepared from the drilling fluids should be used for testing within the same day.

Receipt of Effluent Samples for Initial Toxicity Screening and WET Testing Samples

Upon receipt at the subcontract laboratory, water quality parameters are measured for effluent samples. These parameters include dissolved oxygen, temperature, pH, and salinity/conductivity. Additional parameters such as ammonia and chlorine may be measure if requested or suspected to be a contaminant of concern in the sample. Acceptability criteria for water quality parameters are included in Section 2.6.

2.4.6.4 Holding Times

Sample holding time begins with the collection of the sample and continues until the analysis is complete. Analytical method holding times are included in Table 2-27.

Testing for toxicity samples should be initiated on samples within 36 hours of sample collection, but must not exceed 72 hours as prescribed in the General Permit and method guidance. Effluent samples used for test solution renewals on the WET 7-day chronic tests (days 1-6) may be used up to 48-hours after the

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 63 of 174
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initial use (test initiation) and may be used for test solution renewals at up to 120 hours from the time of collection.

2.4.6.5 Sample Retention and Disposal

Procedures ensuring internal laboratory chain-of-custody shall also be implemented and documented by the subcontract laboratory. Samples shall be stored in limited-access, temperature-controlled areas. Samples will be retained and disposed of in accordance with laboratory procedures.

Samples will be retained under proper storage conditions in the onsite laboratory. Static sheen samples will be retained until the end of the holding time or until the M-I SWACO Compliance Specialist verifies the acceptability of the sample results. In the event, if any, that a sample fails, the sample will be retained until the permittee requests additional testing or provides permission for disposal. After expiration of the sample retention period, mud samples are returned to the active mud system and cuttings samples are placed in the cuttings disposal system.

2.4.6.6 Decontamination

Decontamination is essential for the avoidance of cross-contamination among samples. Reusable, non-dedicated sampling implement is decontaminated before use and after each sample is collected, in accordance with M-I SWACO SOP 2004 Decontamination of Equipment. Generally, sample equipment used for compliance measurements is dedicated equipment and requires minimal decontamination.

2.4.7 Field Instrument/Equipment Testing, Inspection, Calibration, and Maintenance

Effluent limitations in the General Permit involve measurements that shall be made directly in the field – for example, the Free Oil by Static Sheen Method (M-I SWACO SOP 3004). In addition, effluent limitations in the General Permit involve measurements that are made in a fixed subcontract laboratory – for example, cadmium, and mercury in barite and toxicity testing. These measurements involve the use of instrumentation that shall be calibrated and in good working condition in order to fulfill the quality objectives of the General Permit.

This section discusses M-I SWACO's program for calibration and verification of measuring and test equipment used to provide compliance data for the General Permit. Specific procedures for operation, maintenance, and calibration of onsite laboratory instrumentation can be found in the associated M-I SWACO SOP and/or manufacturer's instructions for each instrument.

The subcontract laboratory QA Manual documents the quality system under which the laboratory operates. The testing, inspection, calibration, and maintenance activities for analytical laboratory instrumentation are documented in the subcontract laboratory's QA Manual and SOPs.

2.4.7.1 Responsibilities

The M-I SWACO Compliance Supervisor or designee will be responsible for maintaining, issuing, and tracking field equipment in accordance with this chapter and relevant M-I SWACO SOPs. The Shell Compliance Engineer is responsible for designing QC programs for field measurements and incorporating those measures into the QAPP. M-I SWACO Compliance Specialists are responsible for performing field measurements, and maintaining and calibrating field equipment in accordance with M-I SWACO SOPs, this QAPP, and the General Permit, and for accurately completing the attendant documentation.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 64 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

The storage, preventive maintenance, issuing, and tracking of equipment are the responsibility of the M-I SWACO Compliance Supervisor. The M-I SWACO Compliance Supervisor or designee performs the following tasks:

- Storage of Equipment - Field equipment is kept in a designated, limited-access storage area.
- Controlling access to the storage area.
- Issuing Equipment - Field equipment is issued by the Compliance Supervisor.
- Preventive Maintenance and Repair – The Compliance Supervisor performs preventive maintenance of field equipment in accordance with the manufacturers recommended schedule and procedures.
- Record keeping and tracking – The M-I SWACO Compliance Supervisor maintains one Equipment Manual for each model of equipment in the District Office. The M-I SWACO Compliance Supervisor also keeps records of routine preventive maintenance, repairs and utilization of field equipment in an Equipment Log. Each time a piece of equipment is repaired, or routine maintenance is performed, an entry is made in the logbook, giving the date, nature of repair or maintenance, identification (description and serial number) of the equipment and the initials of the person performing the repairs or maintenance work.

Subcontract laboratories are responsible for performing analytical measurements and maintaining and calibrating equipment in accordance with laboratory SOPs, the laboratory QA Manual, applicable analytical methods, and the General Permit; and for accurately completing the attendant documentation. Subcontract laboratory documentation shall be available for audit or inspection, and equipment and reference material records shall be maintained in accordance with laboratory record retention policy.

2.4.7.2 Onsite Laboratory Equipment

Sampling and analytical procedures are performed at the permittee's drilling rig using M-I SWACO onsite laboratories. The M-I SWACO Compliance Specialist shall provide sampling equipment to safely collect representative samples of drilling fluids and drill cuttings and other effluents. The M-I SWACO Compliance Specialist shall also provide analytical equipment and supplies necessary to perform the Free Oil by Static Sheen Method (M-I SWACO SOP 3004).

M-I SWACO shall maintain duplicate equipment for the Free Oil by Static Sheen Method (M-I SWACO SOP 3004) test at the rig site.

The permittee shall provide M-I SWACO with access to a sample refrigerator that is capable of maintaining the drilling fluid and drill cutting samples at 0 to 4 degrees Celsius (°C). The permittee shall provide a well-ventilated work area with sufficient counter space and adequate fluorescent lighting to perform procedures. Electricity shall be of sufficient voltage and amperage to operate retorts, balances, computers, and ultraviolet light. The permittee shall also provide storage space for the flammable solvent, isopropanol.

2.4.7.3 Field and Onsite Laboratory Instrument Calibration

Instrument calibration comprises initial calibration that is used directly for quantification and continuing calibration verification that is used to confirm the validity of the initial calibration. Analytical procedures

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 65 of 174
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for the onsite laboratory, such as pH analysis, may require initial calibration and/or calibration verification. Analytical procedures for the fixed laboratory analyses may require initial and continuing calibration. Calibration procedures will be described in the applicable laboratory SOPs.

Calibration of thermometers and balance weights shall be verified every two years using National Institute of Standards and Technology (NIST) standards. Each working day, balances and refrigerators, shall be checked in the expected use range with NIST traceable standards. Checks shall be recorded on the equipment logs provided in the applicable SOPs. The equipment logs shall indicate the acceptable range for the check. Corrective actions for calibration results outside the acceptance range shall also be recorded on the equipment logs. If a corrective action is not successful, then the equipment shall be removed from service.

Calibration Procedures

Equipment shall be calibrated at the frequency specified in the applicable SOPs. Equipment shall be calibrated using the procedures specified in the applicable SOPs. The appropriate form for recording the calibration of each device is provided in the applicable SOP. The status of equipment with regard to calibration needs to be readily available and clearly indicated on equipment and field logs. Applicable acceptance criteria for equipment inspection and calibration shall be met before any sample collection or sample analyses are performed. Specific procedures for equipment calibration shall be documented in the relevant SOP. The results of the inspection and calibration shall be documented on Equipment Inspection and/or Calibration Forms.

Calibration Verification

Equipment calibration shall be verified by the analysis of appropriate reference materials before samples are collected /analyzed and at the required frequency throughout collection and/or analysis. The results shall be within the acceptance limits for the applicable SOP in order to proceed with sample collection and/or analysis.

Calibrations shall be documented on the Equipment Log (in the District Office) or Equipment Calibration Form (on the Drilling Rig). Records pertaining to calibration shall be safely stored for the period described in M-I SWACO's record retention policy. The following information shall be recorded:

- Date;
- Time;
- Instrument type and serial number;
- Identification of calibration standard;
- True value (numerical result, positive, negative) of calibration standard;
- Response of instrument before repair or adjustment;
- Response of instrument after repair or adjustment; and
- Signature of person performing the calibration.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 66 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Onsite Laboratory Equipment Calibration

Portable analytical instruments (e.g. retorts, balances, and ultraviolet lights) require preventive and corrective maintenance, as well as calibration. Calibrations shall be performed in accordance with the appropriate M-I SWACO SOP and/or manufacturer's instructions. Portable equipment shall be calibrated and inspected prior to and upon return from the field. Onsite laboratory equipment calibration is summarized in Table 2-28.

Table 2-28 Onsite Laboratory Equipment Calibration

Equipment	Calibration Procedure	Calibration Verification		SOP
		Method	Frequency	
Balance	Manufacturer's specifications	Calibration check – 100 g, 500 g, 1000 g, and 2000 g weights	Daily	1004
pH Meter	Manufacturer's Specification	Calibration check by buffer solution(s)	Daily	2012
Refrigerator	Manufacturer's specifications	Verification of operating temperature	Daily	1005

Notes:

g = grams

SOP = standard operating procedure

Complete calibration verification forms as indicated in applicable SOPs. Forms will be maintained on drilling rig until completion of drilling interval. After completion of drilling interval, forms will be archived in the District Office.

2.4.7.4 Standards and Reagents

The M-I SWACO Compliance Specialists shall retain records for standards and reagents, including the manufacturer/vendor, the Certificate of Analysis or purity, the date of receipt, recommended storage conditions, and an expiration date. Original containers shall be labeled with an expiration date and a unique standard or reagent identifier. The standard or reagent identifier shall also be recorded on the Certificate of Analysis or vendor documentation.

Standards and reagents records shall include the purchased stock or neat compound identifier number, a reference to the method of preparation (such as a SOP number) or a description of the preparation (including weights and/or volumes), the date of preparation, the expiration date and the preparer's initials. Each prepared standard and reagent will be assigned a unique identifier that is linked to the documentation described in this paragraph. The container for each standard and reagent will be labeled with the unique identifier and the material expiration date. In order to protect the health and safety of personnel, containers will be labeled with the Hazardous Materials Identification System (HMIS) information.

2.4.7.5 Reference Materials and Standards

Equipment and standards shall be verified before use and on a continuing basis. Traceability and calibration of fixed laboratory equipment will be discussed in the subcontracted laboratory QA Manual. Documentation will be maintained at the fixed laboratory as discussed in Section 1.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 67 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Reference Materials

Reference materials are materials or substances for which one or more properties are sufficiently well established to be used for the calibration of an apparatus, for assessment of methods or for assigning values to materials. Generally reference materials are purchased from third parties such as NIST and are characterized for content, independent of an analytical method. Reference materials used to support data generated for permit compliance include:

- Class F weights
- NIST thermometers

Original certificates are maintained at the District Office and certificate copies are maintained with equipment in the onsite laboratory. Reference materials are removed from service upon expiration of the certificate and may only be placed back into service once the material is recertified.

Reference Standards

Reference standards shall be used for calibration only. Reference standards are removed from service upon expiration of the certificate or if calibration indicates the standard is outside of specifications. If the material is outside of specifications and correction factors can be established, the reference standard may continue in service. The District Office shall maintain original records of the correction factors with the applicable dates. Copies of relevant correction factors shall accompany the material in the field.

Traceability

Calibration certificates shall be provided by the manufacturer and shall indicate traceability to national standards. Class F weights, crude oil standards, and NIST thermometers are examples of materials for which calibration certificates shall be maintained. Certificates that describe purity or composition of standard materials shall also be maintained. Certificates shall be cross-referenced to a material identification, such as equipment number, standard, or reagent number.

2.4.7.6 Refrigerator testing

Refrigerators will be monitored using thermometers that have been calibrated using a NIST-traceable thermometer. Refrigerator temperatures will be monitored daily and the temperature recorded on Form 1005-2 Refrigerator Calibration Log. Thermometer calibration procedures and refrigerator monitoring procedures are included in SOP 1005 Laboratory Refrigerators.

2.4.7.7 Field Compliance Instrument/Equipment Maintenance

Field equipment is maintained under a tracking and preventive maintenance program. When a piece of permit-related equipment is sent to a vendor for repairs or maintenance, a log entry is made giving the date, name of vendor, identification of the equipment, description of services required, and initials of the person sending the equipment. When the equipment is returned, a similar entry is made to document the return and a copy of the repair slip is placed in the Equipment Log.

When equipment is issued, an entry is made in the Equipment Log giving the date, identification of the equipment, initials of the person issuing the equipment and the identity of the person to whom the equipment is issued. When the equipment is returned, a similar entry is made, noting date of return, and

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 68 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

condition of the returned equipment. Through the use of the log, the M-I SWACO Compliance Supervisor maintains a continuous written record of the status and the location of each piece of field equipment.

Equipment that is overdue for scheduled maintenance or is in need of repair is placed “Out of Service”. This equipment shall be clearly identified as “Out of Service” until the repair work has been completed and the equipment is operating satisfactorily. Equipment that is not marked shall be considered in proper working order.

2.4.8 Subcontract Laboratory Instrument/Equipment Testing, Inspection, Calibration, and Maintenance

Testing, inspection, calibration, and maintenance for fixed laboratory equipment is performed in accordance with laboratory QA Manuals and analytical method requirements. Calibration requirements for fixed laboratory equipment are documented in subcontract laboratory SOPs. Subcontract laboratories shall maintain equipment and have in place either a service contract, or sufficient spare parts, such that method holding times or analytical report due dates are not exceeded.

The following sections outline specific equipment, materials, and procedures used by the toxicity testing subcontract laboratory.

2.4.8.1 Toxicity Testing Laboratory Equipment Washing Procedures

All laboratory equipment, glassware, and plasticware used for the toxicity testing program will be cleaned to eliminate potential toxicity associated with labware. Plastic and glassware are scrubbed with a solution of non-phosphate detergent and hot tap water, and then rinsed three times with deionized water. A rinse of 10% solution reagent grade hydrochloric acid is followed by three rinses with deionized water. A rinse of reagent grade acetone is followed by air drying under a fume hood. Acetone is not used on hard plastics. A final three rinses with deionized water is followed by air drying.

2.4.8.2 Toxicity Testing Laboratory Materials

Test Organisms Suppliers

Test organisms used in the toxicity tests will be from either in-house cultures or collected in areas known to be generally free of pollutants, or purchased from reputable culturists. Organisms are purchased from suppliers who are selected based on their reputation, depth of knowledge concerning the test organisms, and their ability to consistently deliver healthy test organisms.

Upon receipt in the laboratory, test organisms will be slowly acclimated to test conditions in environmentally controlled holding areas in accordance with the test protocol for each test organism. Test organisms will be evaluated on a performance basis for every test conducted in the laboratory. Negative controls will be tested concurrent to each study to evaluate the health of the test organisms and the acceptability of the test conditions. Positive controls (reference toxicant tests) will also be conducted to assess the relative sensitivity of test organisms compared to historical laboratory performance.

Source of Seawater

Seawater diluent that will be used in this study will come from the northern Hood Canal at Port Gamble, Washington. This water source (used as the laboratory control and sample diluent) has been used successfully on a wide range of bioassay testing programs. Artificial seawater may also be prepared from

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 69 of 174
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deionized water and bioassay-grade sea salts (Crystal Sea Marinemix™) if necessary. Extensive testing with a variety of test species has shown that there is no significant potential for toxicity or bioaccumulation from these water supplies. Chemical analyses are performed annually on these water sources and have shown no significant contaminants of concern or bioaccumulation potential.

2.5 Laboratory Analysis

The subcontract laboratories that are proposed for use for the analysis of compliance monitoring samples are listed for the corresponding preparation and analytical methods in Table 2-29.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 70 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Table 2-29 Analytical Subcontract Laboratories

Analytical Parameter	Matrix	Preparation/ Analytical Method	Laboratory/Organization
Metals (Cd, Hg)	Stock barite (solid)	SW3050/SW6020	SGS North America, Inc. 200 W. Potter Drive Anchorage, AK 99518 (907) 562-2343 Main (907) 561-5301 Fax
TAH/TAqH	Aqueous	SW5030B/E624 SW3520C/E625 SIM	
Diesel fingerprinting	Aqueous Oil	SW3520C/SW8015C SW3550C/SW8015C	
BOD ₅	Aqueous	SM5210-B	
TSS	Aqueous	SM2540-D	
Fecal coliform	Aqueous	SM9222-D	SGS North America, Inc. 200 W. Potter Drive Anchorage, AK 99518 (907) 562-2343 Main (907) 561-5301 Fax Arctic Fox Environmental, Inc. Pouch 340043 Prudhoe Bay, AK 99734 (907) 659-2145 Main (907) 659-2146 Fax
SPP toxicity	Aqueous	40 CFR Part 435, App. 2 to Subpart A (E1619)	NewFields 4729 NE View Drive Port Gamble, WA 98364 (360) 297-6040 Main Environmental Enterprises USA, Inc. 58485 Pearl Acres Road, Suite D Slidell, LA 70461 (800) 966-2788 Main (985) 646-2810 Fax
Initial toxicity screening	Aqueous	EPA/600/R-95-136 (Echinoderm Fertilization Test)	
WET testing	Aqueous	EPA/600/R-95-136 (Topsmelt Chronic 7d Survival and Growth Test) or EPA/821-R-02-014 (Menidia Chronic 7d Survival and Growth Test)	
		EPA/821-R-02-014 (Mysid Chronic 7d Survival, Growth, and Fecundity Test)	
		EPA/600/R-95-136 (Echinoderm Larval Development Test)	

Notes:

BOD₅ = biochemical oxygen demand
SPP = suspended particulate phase
TAH = total aromatic hydrocarbons

TAqH = total aqueous hydrocarbons
TSS = total suspended solids
WET = whole effluent toxicity

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 71 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

2.5.1 Analytical Laboratory Methods

Evaluation of the effluent limits and laboratory quantitation limits is required to ensure that project data quality objectives are met. Laboratory-specific detection limits and reporting limits will be evaluated against the permit effluent limitations to determine whether the sensitivity of the data will be sufficient for its intended use.

Proposed drilling fluid and effluent toxicity testing methods are summarized in Table 2-30. The initial toxicity screening of effluent discharges will utilize the Chronic Toxicity Fertilization Test using echinoderms (*Strongylocentrotus purpuratus* or *Dendraster excentricus*) as outlined in the “Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to West Coast Marine and Estuarine Organisms” (EPA/600/R-95-136).

The methods for WET testing are provided in established EPA procedures outlined in “Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Marine and Estuarine Organisms” (EPA-600-4-91-003-Third Ed.) and the “Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to *West Coast* Marine and Estuarine Organisms” (EPA/600/R-95-136). The WET testing program will use three different species of organisms including the topsmelt, *Atherinops affinis* (or *M. beryllina*-depending on availability), the mysid shrimp, *Americamysis bahia*, and the purple sea urchin, *Strongylocentrotus purpuratus*.

Table 2-31 presents subcontract laboratory analytical methods, detection limits, and reporting limits for effluent monitoring.

Table 2-30 Drilling Fluid and Effluent Toxicity Testing Methods

Toxicity Test	Test Description	Species	Method
Drilling fluid SPP toxicity	Mysid 96-Hour Survival Test	<i>Americamysis bahia</i> (Formerly <i>Mysidopsis bahia</i>)	40 CFR Part 435 EPA-821-R-11-004 EPA-821-R-02-012
Initial toxicity screening test	Chronic Toxicity Echinoderm Fertilization Test	Purple Sea Urchin (<i>Strongylocentrotus purpuratus</i>) or Sand Dollar (<i>Dendraster excentricus</i>)	EPA/600/R-95/136
Marine Chronic Toxicity Test (WET testing)	Larval Fish 7-Day Larval Survival and Growth Test	Topsmelt (<i>Atherinops affinis</i>) or Inland Silverside ¹ (<i>Menidia beryllina</i>)	EPA/600/R-95/136 EPA-821-R-02-014
	Mysid Shrimp 7-Day Larval Survival, Growth, and Fecundity Test	<i>Americamysis bahia</i> (Formerly <i>Mysidopsis bahia</i>)	EPA-821-R-02-014
	Echinoderm Larval Survival and Development Test	Purple Sea Urchin (<i>Strongylocentrotus purpuratus</i>) or Sand Dollar (<i>Dendraster excentricus</i>)	EPA/600/R-95/136

Notes:

¹ *Menidia beryllina* may be used as a substitute for topsmelt.

EPA = U.S. Environmental Protection Agency

SPP = suspended particulate phase

WET = whole effluent toxicity

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 72 of 174
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Table 2-31 Analytical Laboratory Reporting Limits

Analytical Method	Analyte	Matrix	Permit Limit	Units	DL	RL
SW6020	Cadmium	Stock barite	3	mg/kg	0.062	0.2
SW6020	Mercury	Stock barite	1	mg/kg	0.012	0.04
SM5210-B	BOD ₅	Aqueous	30	mg/L	2	2
SM2540-D	TSS	Aqueous	30	mg/L	0.15	0.5
SM9222-D	Fecal coliform	Aqueous	100	col/100 mL	1	1
E624	Benzene	Aqueous	NA	µg/L	0.12	0.4
E624	Toluene	Aqueous	NA	µg/L	0.31	1
E624	Chlorobenzene	Aqueous	NA	µg/L	0.15	0.5
E624	Ethylbenzene	Aqueous	NA	µg/L	0.31	1
E624	P & M -Xylene	Aqueous	NA	µg/L	0.62	2
E624	o-Xylene	Aqueous	NA	µg/L	0.31	1
E624	1,3-Dichlorobenzene	Aqueous	NA	µg/L	0.31	1
E624	1,4-Dichlorobenzene	Aqueous	NA	µg/L	0.15	0.5
E624	1,2-Dichlorobenzene	Aqueous	NA	µg/L	0.31	1
E625 SIM	Acenaphthene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Acenaphthylene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Anthracene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Benzo[a]anthracene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Benzo[a]pyrene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Benzo[b]fluoranthene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Benzo[g,h,i]perylene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Benzo[k]fluoranthene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Chrysene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Dibenzo[a,h]anthracene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Indeno[1,2,3-c,d] pyrene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Fluoranthene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Fluorene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Naphthalene	Aqueous	NA	µg/L	0.031	0.1
E625 SIM	Phenanthrene	Aqueous	NA	µg/L	0.015	0.05
E625 SIM	Pyrene	Aqueous	NA	µg/L	0.015	0.05
SW8015C	Diesel Range Organics	Aqueous	NA	mg/L	0.15	0.4
SW8015C	Diesel Range Organics	Oil	NA	mg/kg	620	2000

Notes:

SGS North America, Inc. DLs and RLs.

BOD₅ = biochemical oxygen demand

DL = detection limit

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

µg/L = micrograms per liter

RL = reporting limit

SPP = suspended particulate phase

TSS = total suspended solids

TU_c = chronic toxic units

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 73 of 174
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2.6 Field and Laboratory Quality Control Samples

2.6.1 Field Quality Control Samples and Frequencies

Field QC samples that will be collected and/or submitted include field duplicates, MS/MSDs, trip blanks, and temperature blanks. Field QC samples will be collected and/or submitted at the following frequencies:

- Field duplicates will be collected at a frequency of one per ten or fewer primary samples for each analyte and matrix as described in Table 2-32.
- MS and MSD samples will be collected for every 20 or fewer samples as described in Table 2-32.
- Trip blanks will be submitted with every cooler for every shipment containing volatile samples.
- Temperature blanks will be submitted with every cooler containing analytical samples.

Table 2-32 summarizes the type and quantity of QC samples required for compliance monitoring.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 74 of 174
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Table 2-32 Field Quality Control Samples

Discharge	Matrix	Monitoring Parameter	Method	Sampling Frequency	Field Duplicate	MS/MSD ¹	Trip Blank Required?
Discharge 001 Water-based drilling fluids and drill cuttings	Stock barite	Mercury and Cadmium	SW6020	Prior to drilling, or new supply of barite	One duplicate per 10 or fewer samples	One MS/MSD per 20 samples	NA
	Water-based drilling fluids and drill cuttings	SPP toxicity	E1619	Weekly and end of well	Duplicate collected each time a primary sample is collected ²	NA	NA
		TAH	E624	Once per well	One duplicate per 10 or fewer samples	One MS/MSD per 20 samples	Yes
		TAqH	E625 SIM	Once per well	One duplicate per 10 or fewer samples	One MS/MSD per 20 samples	NA
		Diesel oil (Diesel-range organics)	SW8015C	Once per well, or if static sheen test fails	One duplicate per 10 or fewer samples	One MS/MSD per 20 samples	NA
	Diesel oil in storage	Diesel oil (Diesel-range organics)	SW8015C	If static sheen test fails	NA	NA	NA
Discharge 002 Deck Drainage	OWS effluent	TAH	E624	Once per discharge event	One duplicate per 10 or fewer samples	One MS/MSD per 20 samples	Yes
	OWS effluent	TAqH	E625 SIM	Once per discharge event	One duplicate per 10 or fewer samples	One MS/MSD per 20 samples	NA
Discharge 003 Sanitary Wastes	MSD effluent	BOD ₅	SM5210-B	Weekly	NA	NA	NA
	MSD effluent	TSS	SM2540-D	Weekly	NA	NA	NA
	MSD effluent	Fecal coliform bacteria	SM9222-D	Weekly	NA	NA	NA

Notes:

¹ Triple volume of sample must be collected for MS/MSD for organic analyses. Two sample volumes must be collected for inorganic analyses.

² A duplicate sample volume will be collected with each primary sample. The duplicate volume will be retained in the onsite laboratory refrigerator until acceptable results are received for the sample transported to the laboratory. If a problem occurs with the original sample that invalidates the results, the duplicate volume of sample will be packaged and transported to the subcontract laboratory for analysis.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 75 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 76 of 174
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2.6.2 Laboratory Quality Control

2.6.2.1 Analytical Method Quality Control Criteria

Quality control checks for sample collection will be accomplished by a combination of CoC protocols, field QA samples, and laboratory QC as prescribed in the sampling or analytical methods. Laboratory QC samples will be prepared and analyzed as required by the analytical methods and laboratory QA Manuals. Results from LCS/LCSD and MS/MSD samples will be compared to criteria for accuracy and precision listed in Table 2-33.

Table 2-33 Analytical Method Quality Control Criteria

Analytical Method	Analyte	Matrix	Laboratory Control Limits (Accuracy)		RPD (Precision)
			LCL (%)	UCL (%)	
SW6020	Cadmium	Stock barite	80	120	20
SW6020	Mercury	Stock barite	80	120	20
SM5210-B	BOD ₅	Aqueous	84.6	115.4	20
SM9222-D	Fecal coliform	Aqueous	NA	NA	NA
SM2540-D	TSS	Aqueous	75	125	5
E624	Benzene	Aqueous	80	120	20
E624	Toluene	Aqueous	75	120	20
E624	Chlorobenzene	Aqueous	80	120	20
E624	Ethylbenzene	Aqueous	75	125	20
E624	P & M -Xylene	Aqueous	75	130	20
E624	o-Xylene	Aqueous	80	120	20
E624	1,3-Dichlorobenzene	Aqueous	75	125	20
E624	1,4-Dichlorobenzene	Aqueous	75	125	20
E624	1,2-Dichlorobenzene	Aqueous	70	120	20
E625 SIM	Acenaphthene	Aqueous	45	110	30
E625 SIM	Acenaphthylene	Aqueous	50	105	30
E625 SIM	Anthracene	Aqueous	55	110	30
E625 SIM	Benzo[a]anthracene	Aqueous	55	110	30
E625 SIM	Benzo[a]pyrene	Aqueous	55	110	30
E625 SIM	Benzo[b]Fluoranthene	Aqueous	45	120	30
E625 SIM	Benzo[g,h,i]perylene	Aqueous	40	125	30
E625 SIM	Benzo[k]fluoranthene	Aqueous	45	125	30
E625 SIM	Chrysene	Aqueous	55	110	30
E625 SIM	Dibenzo[a,h]anthracene	Aqueous	40	125	30
E625 SIM	Indeno[1,2,3-c,d] pyrene	Aqueous	45	125	30
E625 SIM	Fluoranthene	Aqueous	55	115	30
E625 SIM	Fluorene	Aqueous	50	110	30
E625 SIM	Naphthalene	Aqueous	40	100	30

Analytical Method	Analyte	Matrix	Laboratory Control Limits (Accuracy)		RPD (Precision)
			LCL (%)	UCL (%)	
E625 SIM	Phenanthrene	Aqueous	50	115	30
E625 SIM	Pyrene	Aqueous	50	130	30
SW8015C	Diesel Range Organics	Aqueous	75	125	20
SW8015C	Diesel Range Organics	Oil	NA	NA	NA

Notes:

BOD5 = biochemical oxygen demand
LCL = lower control limit
RPD = relative percent difference
TSS = total suspended solids
UCL = upper control limit
WET = whole effluent toxicity

For operational discharge compliance sampling under the General Permit, the completeness goal is 100%. If a sample is determined to be invalid or unusable, the sample will be recollected immediately. The Compliance Specialist will be responsible for ensuring that all samples are collected as required by the permit.

2.6.2.2 Toxicity Testing Quality Control Criteria

The test acceptability criteria and performance standards for the proposed toxicity tests are summarized in Tables 2-34 and 2-35. The toxicity tests incorporate standard QA/QC procedures to ensure that the test results are valid. Standard QA/QC procedures include the use of negative and positive controls, the use of testing replicates, and water quality monitoring. All limits established for this program meet or exceed those recommended by USEPA.

All data collected and produced will be recorded on approved data sheets, which will become part of the permanent data record of the program. If any aspect of a test deviates from protocol, the test will be evaluated to determine whether it is valid according to test acceptability criteria and performance standards.

Each toxicity test includes sample replication of 3 to 8 replicates, depending on the test. The data generated are checked by the responsible laboratory technician and reviewed independently by another analyst to assess precision. The maximum percent difference (MPD) for replicates and the reference toxicant tests are evaluated relative to the permissible bounds of the methods. Acceptable accuracy levels are also assessed by the calibration of water quality instruments, the use of certified standards, and the establishment of acceptable water quality testing parameters. For example, water quality is monitored and, adjusted if necessary, throughout testing in at least one test replicate. Parameters that fall outside of acceptable test ranges may require corrective action.

The sensitivity of test organisms will be evaluated using positive control reference toxicant tests. Reference toxicant tests will be conducted on each batch of test organisms either concurrently with project samples or monthly, as specified under the QA requirements for each test. The reference toxicant test will consist of an exposure to at least five concentrations of a reference substance (known toxicant) used to assess the health and sensitivity of the test organisms. The test duration and endpoint will mimic

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 78 of 174
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those of the corresponding bioassay. Dilutions will be selected to bracket laboratory historical LC₅₀/EC₅₀. The LC₅₀/EC₅₀ results will be compared with historical data from definitive bioassays with the reference substance. The reference toxicant substances will be copper sulfate, ammonium chloride, or other toxicants as appropriate for evaluating the sensitivity of test organisms.

Table 2-34 Water Quality Criteria and Performance Standards

Analyte	Water Quality Test Parameters Acceptability Criteria			
	Dissolved oxygen	Temperature	pH	Salinity
Drilling Fluid (Mud) SSP Mysid Acute Survival Toxicity Test	Aeration to maintain DO > 5.3 mg/L	20 ± 2°C	6 – 9 ³	20 ± 2 ppt
Chronic Toxicity Echinoderm Fertilization Test	DO > 4.0 mg/L	12 ± 1°C	6 – 9	30 ppt ¹
Larval Fish 7-Day Chronic Survival and Growth Test	Aerate if DO < 4.0 mg/L	20 ± 1°C	6 – 9	5 – 34 ppt ¹
Larval Fish 7-Day Chronic Survival and Growth Test	Aerate if DO < 4.0 mg/L	25 ± 1°C	6 – 9	5 – 32 ppt ¹
Mysid Shrimp 7-Day Larval Survival, Growth, and Fecundity Test	Aerate if DO < 4.0 mg/L	26 ± 1°C	6 – 9	20 – 30 ppt ¹
Echinoderm Larval Survival and Development Test	Aerate if DO < 4.0 mg/L ²	15 ± 1°C	6 – 9	32 ± 2 ppt

Notes:

¹ Target should not deviate by ± 2 ppt during test period.

² No aeration during testing.

³ 7.8 ± 0.1 (at initiation in the 100% elutriate).

Table 2-35 Toxicity Test Acceptance Criteria and Performance Standards

Test Organism (Protocol – SOP)	Test Acceptability Criteria
Drilling Fluid (Mud) SPP Mysid Acute Survival Toxicity Test (40 CFR Part 435, EPA-821-R-11-004, EPA-821-R-02-012 – SOP No. SED026.01)	1. Survival in the controls $\geq 90\%$
Chronic Toxicity Echinoderm Fertilization Test (<i>Strongylocentrotus purpuratus</i> or <i>Dendraster excentricus</i>) (EPA/600/R-95/136, WDOE WQ-R-95-80 – SOP No. TOX045.01)	<ol style="list-style-type: none"> At least 70% fertilization in controls The dilution water and the effluent egg blanks have essentially no eggs with fertilization membranes. Minimum significant difference (MSD) of $<25\%$ Final sperm stock concentration must be $\leq 33,600,000$ sperm/mL <u>AND</u> one of the following conditions: <ol style="list-style-type: none"> Trial fertilization used – final sperm stock must not exceed double the target density selected that would provide 70-$<100\%$ fertilization without oversperming Sperm/egg ratio kept at $\leq 500:1$ (without trial fertilization) and confirmation of sperm stock $\leq 5,600,000$ sperm/mL Use any reasonable sperm stock density and run two extra sets of controls (high and low density). The high density control (0.200 mL of sperm stock) must have at least 5% higher fertilization than the low density control (0.050 mL of sperm stock)
Larval Fish 7-Day Chronic Survival and Growth Test Topsmelt (<i>Atherinops affinis</i>) (EPA/600/R-95/136 – SOP No. TOX002.003)	<ol style="list-style-type: none"> Survival in the controls $\geq 80\%$ 0.85 mg average weight of control larvae (9 days old)
Larval Fish 7-Day Chronic Survival and Growth Test Inland Silverside (<i>Menidia beryllina</i>) (EPA-821-R-02-014 – SOP No. TOX012.04)	<ol style="list-style-type: none"> Survival in the controls $\geq 80\%$ 0.50 mg average weight of control larvae (7 days old)
Mysid Shrimp 7-Day Larval Survival, Growth, and Fecundity Test (EPA/821-R-02-14 – SOP No. TOX014B.01)	<ol style="list-style-type: none"> Survival in the controls $\geq 80\%$ 0.20 mg average weight of control larvae (7 days old) MSD for growth $\leq 37\%$ Egg production in $\geq 50\%$ of females
Echinoderm Larval Survival and Development Test (EPA/600/R-95/136 – SOP No. TOX043.04)	<ol style="list-style-type: none"> Normal development in the controls $\geq 80\%$ MSD for growth $< 25\%$

Notes:

EPA = U.S. Environmental Protection Agency
mL = milliliter
MSD = minimum significant difference
SPP = suspended particulate phase
SOP = standard operating procedure

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 80 of 174
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2.7 Documents and Records

2.7.1 Responsibilities

A records custodian within the Shell Regulatory Affairs group establishes and maintains the central files for project records, training records, qualified subcontractor files, and other important documentation. Each M-I SWACO Compliance Specialist is responsible for assembling supporting documentation generated in his or her task and forwarding the documentation to the Shell Regulatory Affairs record custodian and the M-I SWACO Compliance Supervisor at the end of the season. In addition, the M-I SWACO Compliance Specialist is responsible for providing the onsite laboratory reports to the permittee.

The M-I SWACO Compliance Supervisor and other signatories shall approve revisions of controlled documents such as the QAPP and associated SOPs and LWIs. The M-I SWACO Compliance Supervisor is responsible for determining, through consultation with technical staff, the activities that require SOPs or LWIs, and for working with the appropriate technical experts to develop the SOPs and LWIs. The M-I SWACO Compliance Supervisor is responsible for obtaining technical review and approval of SOPs and LWIs, for maintaining control of QAPP and revisions, and for maintaining an up-to-date distribution list for SOPs and LWIs.

M-I SWACO Compliance Specialists are responsible for performing tasks in accordance with applicable SOPs and LWIs, except as explicitly directed by the relevant contract or Health and Safety policy. M-I SWACO Compliance Specialists are responsible for maintaining copies of applicable SOPs and LWIs at the onsite laboratory locations, performing the procedures defined in the SOP or LWI, maintaining documentation as required by the SOP or LWI, and notifying management of deviations from SOPs and LWIs. M-I SWACO Compliance Specialists are also responsible for assisting the Shell Compliance Engineer and/or the M-I SWACO Compliance Supervisor in designing accurate and practical SOPs and LWIs, and in keeping the SOPs and LWIs up-to-date.

2.7.2 Field and Laboratory Records

M-I SWACO shall retain copies of observations, calculations and derived data, calibration records, and a copy of the test report in accordance with the BMP and permit requirements. Records that are generated or stored by computers shall have hard copy or write-protected backup copies. Field notebooks shall be assigned an identification number and each page of the notebook shall be sequentially numbered. The M-I SWACO Compliance Supervisor shall maintain completed notebooks, hard copy electronic records, write-protected backup records, and test reports. Records that are expected to be generated to document compliance with drilling fluid and effluent monitoring requirements are provided in Table 2-36.

The records shall include the identity of the personnel involved in sampling, sample receipt, preparation calibration, and testing. Data, except those generated by automatic data collection systems, shall be recorded directly, promptly, and legibly in permanent ink.

Changes to records shall be signed or initialed by responsible staff. Entries shall not be obliterated by methods such as erasures, overwritten files, or markings. Corrections to recordkeeping errors shall be made by one line marked through the error. The individual making the corrections shall sign (or initial) and date the correction. This requirement also applies to electronically maintained records.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 81 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 82 of 174
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Table 2-36 General Permit Compliance Records by Location

Record	Quality Assurance/ Central Project Files	Compliance Specialist Notebook	Drilling Interval Notebook	M-I SWACO Regional Office
Quality Assurance Project Plan (QAPP)	√ (Original)	√ (Copy) ²		
Audit Reports	√ (Original)	√ (Copy)		
HSE Manual	√ (Copy)	√ (Copy) ²		
Material Safety Data Sheet (MSDS)	√ (Copy)	√ (Copy) ²		
SOPs and LWIs	√ (Copy)	√ (Copy) ²		√ (Original)
Personnel Qualifications	√ (Copy)			√ (Original) ¹
Training Documentation Form	√ (Copy)			√ (Original) ¹
Demonstration of Capability	√ (Copy)	√ (Copy)		√ (Original) ¹
Computer Program Verification	√ (Original)			
Equipment Manuals	√ (Original)	√ (Copy)		
Reference Material Certificates	√ (Original)	√ (Copy)		
Equipment Log	√ (Original)	√ (Copy)		
Field Notebook	√ (Archive Copies) ³	√ (Copy)	√ (Drilling Interval) ⁶	
Daily Activity Report	√ (Archive Copies) ³	√ (Copy) ²	√ (Drilling Interval) ⁶	
Equipment calibration forms	√ (Archive Copies) ³	√ (Copy)	√ (Drilling Interval) ⁶	
Sample chain-of-custody forms	√ (Archive Copies)	√ (Copy)	√ (Drilling Interval) ⁶	
Analytical reports from onsite laboratory	√ (Archive Copies) ^{3,4,5}	√ (Copy)	√ (Drilling Interval) ⁶	
Analytical laboratory data packages	√ (Archive Copies) ^{3,4,5}		√ (Drilling Interval) ⁶	
Certification of Compliance – mercury and cadmium content in Barite	√ (Archive Copies) ³	√ (Copy)	√ (Drilling Interval) ⁶	
Drilling Fluid Inventory	√ (Archive Copies) ³		√ (Drilling Interval) ⁶	
Monthly Discharge Flow Volume Report	√ (Archive Copies) ³		√ (Drilling Interval) ⁶	
Static Sheen Results	√ (Archive Copies) ³	√ (Copy)	√ (Drilling Interval) ⁶	

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 83 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.		

*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

Notes:

¹ Certified copy.

² Electronic copy.

³ Onsite laboratory records will be retained in accordance with the permit requirements. Fixed laboratories shall maintain originals of their analytical data in accordance with their internal QA programs.

⁴ Including QC results, if applicable.

⁵ Copy of CoC document, with recipient's signature at sample transfer to be filed. Sample transfer is defined as the point at which the sample is delivered to any third party.

⁶ Originals provided to permittee at required frequency (e.g., at end of drilling interval or end of well).

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 84 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

2.7.2.1 Deviations

Deviations from SOPs, if any, shall be documented on Corrective Action Report Forms (Table 2-37).

CAR No. _____

Date: _____

Table 2-37 Service Quality Non-Conformance Report

To:	From:
Findings or Deviations	
Answer Due Date	Signature
Review and Comments	
Date	Signature
Review and Comments	Follow up Actions

2.8 Reporting

2.8.1 Notifications

If any of the discharge limits are exceeded or if other suspected BMP Plan noncompliance or modification occurs, the Shell Anchorage Office must be called immediately. Noncompliance of the NPDES General Permit that may endanger health or the environment (if any) must be reported to the EPA by telephone within 24 hours from the time of occurrence. This includes any unanticipated bypass or upset that exceeds discharge limitations in the permit or any violation of maximum daily discharge limitations for any of the pollutants listed in Part 1 of the General Permit requiring 24-hr reporting.

If NPDES General Permit noncompliance occurs, the Shell Anchorage Office will complete and file the necessary reports to the EPA in accordance with permit requirements.

2.8.2 Discharge Monitoring Reports

All discharge monitoring results and effluent sampling will be summarized in the Discharge Monitoring Report (DMR) form EPA No. 3320-1 or equivalent. Monitoring data and other reports will be submitted electronically using NetDMR (<http://www.epa.gov/netdmr>). DMRs will be submitted to EPA no later than the 20th of the month following the completed reporting period.

All permit records are submitted to Shell. Annual sampling results will be reported on the January DMR. All records of monitoring information shall be retained at least 5 years from the date of the sample, measurement, report, or application.

The permittee must ensure that records of monitoring information include:

- The date, exact place, time of sampling or measurements, and the name(s) of the individual(s) who performed the sampling or measurements;
- The date(s) analyses were performed and the names of the individual(s) who performed the analyses;
- The analytical techniques or methods used; and
- The results of such analyses.

Noncompliance reporting that is not required to be reported within 24 hours is to be included with the Discharge Monitoring Reports and submitted monthly. Shell is to preserve all reports and records for a period of at least five years from the date of sample, measurement, report, or application, or for the term of this permit, whichever is longer.

2.8.3 TAH/TAqH Reporting

Total aromatic hydrocarbons, or TAH, is determined by summing the results of EPA Method 602 (plus xylenes) or EPA Method 624 to quantify monoaromatic hydrocarbons. Total aqueous hydrocarbons, or TAqH, are determined by summing the results for TAH and EPA Method 610 or EPA Method 625 (to quantify PAHs listed in EPA Method 610). For samples where one or more analytes has a detectable result, TAH and TAqH will be presented as the sum of the detectable results. Detectable results include results that are reported as estimated (e.g., J-flagged) because the result is greater than the detection limit

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 86 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

and less than the reporting limit. If all results for the sample are nondetect, the reporting limits for all nondetect results will be summed.

2.9 Data Reporting

A group of samples submitted to the subcontract laboratory at the same time and included on the same CoC form will be considered a sample delivery group. The results for this sample delivery group will be reported as one analytical data package. The analytical data package must contain adequate information to verify the quality of the data and be presented in a clear and concise manner. Data packages must include, at minimum, the following elements:

- Cover sheet, which identifies the project;
- Table of contents;
- Case narrative, which documents all discrepancies with the data contained in the report, including (but not limited to) sample receipt, holding time(s), documentation of QC discrepancies and corrective action, matrix interferences;
- Preparation and analytical methods used;
- Sample identification;
- Analytical results, including detection limits, reporting limits, and dilution factors;
- Laboratory qualifiers;
- Date(s)/time(s) of collection, receipt, preparation, analysis;
- Sample receipt and management records; and
- QA/QC sample results and supporting information.

The toxicity testing laboratory is required to report results that include all information recommended by the test protocols for quality assurance review and data validation, as follows:

- Test methods used for toxicity testing and statistical analyses;
- Source of testing water including a description of any pretreatment, and results demonstrating survival and growth of test organism in test water;
- Source, history, and age of test organisms and if appropriate culturing information, or collection information. Records should include information regarding taxonomic identification of test organisms;
- Source of food composition and procedures used to prepare and dispense food to test chambers;
- Description of experimental design including test setup, test monitoring, and test termination. Water quality and observation records should be summarized and included in report;
- Methods used for physical and chemical characterization of test matrices;
- A table of biological data for each sample, including negative and positive control information;

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 87 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

- Methods used for statistical analysis;
- A description of any deviations from the methodology or problems with the process and procedures of analyses;
- Original data sheets for water quality, survival, growth, abnormalities, reference toxicant, and statistics as applicable by test protocol;
- Chain-of-custody records; and
- References and literature.

2.10 Data Review and Qualification

All analytical data that the laboratory generates shall be verified before submittal to the permittee. This internal data review process, which is multi-tiered, shall include all aspects of data generation, reduction, and QC assessment. All definitive data shall be reviewed first by the analyst, and then by the supervisor of the respective analytical section using the same criteria. Elements for review or verification at each level must include, but are not limited to, the following:

- Sample receipt procedures and conditions;
- Sample preparation;
- Appropriate analytical SOPs and methodologies;
- Accuracy and completeness of analytical results;
- Correct interpretation of all raw data, including all manual integrations;
- Appropriate application of QC samples and compliance with established control limits;
- Verification of data transfers;
- Documentation completeness; and
- Accuracy and completeness of data deliverables (hard copy and electronic).

2.10.1 Laboratory Data Evaluation

The calibration, QC, corrective actions, and flagging requirements will be performed in accordance with the laboratory QA Manual and the analytical methods. The laboratory shall apply data qualifiers as part of its internal validation activities. Flagging criteria apply when acceptance criteria are not met and when corrective actions are not successful or not performed. The supervisor of the respective analytical sections shall review the data qualifiers.

The laboratory's QA section shall perform internal review prior to issuance of the final data packages. The laboratory project representative shall complete a final review on all of the completed data packages and issue the final reports.

2.10.2 Data Review and Verification

Staff reviewing permit compliance data will conduct a QA/QC review and assessment of laboratory data deliverables, including an evaluation of:

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 88 of 174
CAUTION: All hardcopies of "Controlling Document" are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

- The information provided on the analytical data sheets, including QC sample results;
- The laboratory case narrative and any flags that the laboratory applied as part of its data validation and usability assessment;
- The sample collection documentation, including CoC records; and
- Field laboratory data sheets and supporting documentation.

This review will also verify the accuracy and completeness of field activities, including the adherence to the procedures as described in the cited SOPs and the specified analytical methods.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 89 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 90 of 174
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3.0 Environmental Monitoring Program

3.1 Introduction and Overview

In the management of its activities, Shell has contracted with Olgoonik-Fairweather, LLC for the implementation of the Environmental Monitoring Program (EMP) portion of its exploration program in the Chukchi Sea. This section addresses those General Permit compliance tasks that will be performed by Olgoonik-Fairweather LLC under contract to the permittee during offshore drilling exploration.

3.2 EMP Roles and Responsibilities

Roles and responsibilities for implementing the Chukchi Sea EMP are summarized below.

The primary roles of Shell are listed as the following:

- Manage and lead the overall operations of the Environmental Discharge Program effort;
- Establish objectives, philosophies and strategies;
- Manage Health, Safety, Security, and Environment (HSSE) with the contractor through the established Bridging Document;
- Coordinate all stakeholder engagements including other Shell teams and third parties; and
- Manage all federal regulatory and environmental permits, consents, and approvals.

The primary roles of each contractor are to:

- Accomplish work per Shell's Goal Zero Program and within the contract budget according to the project schedule;
- Manage HSSE with Shell through the established Bridging Document;
- Manage all local regulatory and environmental permits, consents, and approvals;
- Deliver quality data;
- Complete and document training prior to mobilization; and
- Develop work procedures.

The **Shell Alaska Scientific Lead** is responsible for the project's scope of work, technical input on the equipment specifications necessary to gather the required data, and participation in the identification of risks, opportunities, and hazards. The Shell Alaska Scientific Lead is also responsible for ensuring the technical quality of the field program and data acquisition efforts, as well as data analysis and reporting.

The **Shell Project Lead** is responsible for the planning, coordination, and execution of the seasonal program as defined by the Shell Alaska Scientific Lead. The Project Lead also oversees the projects assets and contractors to achieve the safety, environmental, regulatory, stakeholder, and operational requirements established herein.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 91 of 174
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The 3rd Party **Project Manager** is responsible for the planning, coordination, and execution of the seasonal program as defined by Shell. The Project Manager also oversees the projects assets and sub-contractors to achieve the safety, environmental, regulatory, stakeholder, and operational requirements.

The 3rd Party **Project Lead Scientist** is responsible for field sampling management and support; collection of sediment, water, and tissue samples for chemical analyses in Phases II, III and IV; coordinating environmental chemistry sample transfer logistics for Phases II, III, and IV; coordinating chemical and toxicological sample analyses for Phases II, III, and IV; and reporting.

The **Sea Bottom Survey team** is responsible for collecting photographs, processing, and interpretation of data collected.

The **Environmental Chemistry team(s)** is responsible for sampling activities in Phase II, including accessing and evaluating acoustic Doppler current profiler (ADCP) data, providing and operating conductivity, temperature, depth (CTD)/Rosette systems, collecting water samples and analysis of samples collected. The Environmental Chemistry team(s) is also responsible for sampling activities in phases III and IV including collection of samples for metals and hydrocarbon analysis in sediment and tissue of samples collected.

The **Toxicology team** is responsible for sample collection and toxicological analyses, initial toxicology screen, and WET testing.

The **Benthic team** is responsible for field collection, onboard sample processing, and laboratory analysis of samples for benthic community analysis.

Phase II and III sampling vessel services will be provided by Shell. Phase IV sampling vessel services will either be provided by Shell or the project management team. The Vessel Master(s) has overall vessel maritime command and remains ultimately responsible for the safety of the ship and all personnel onboard. At all times, the Vessel Master shall retain the authority and the right to suspend any operation he may deem unsafe. Shell will be responsible for sample shipping logistics to shore.

Table 3-1 defines the roles and responsibilities of the EMP implementation team. The specific details of responsibilities may change during the project execution. Changes will be documented and communicated to the project team to ensure that project personnel are aware of appropriate points of contact and to avoid any gaps in responsibilities.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 92 of 174
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Table 3-1 Roles and Responsibilities of the EMP Implementation Team

Role	Responsibilities
Project Lead (PL)	<ul style="list-style-type: none"> • Ultimate program responsibility and management • Permitting • Accounting • Stakeholder communication
Health, Safety, Security and Environment (HSSE) Lead	<ul style="list-style-type: none"> • Define HSE training requirements for field team • Ensure HSE requirements are implemented in the field
Project Manager (PM)	<ul style="list-style-type: none"> • Project management • Oversight of contractors, including cost and performance
Scientific Lead (SL)	<ul style="list-style-type: none"> • Development of EMP design and QAPP • Coordination and approval of study reports • Oversight of field and analytical activities
Project Quality Assurance Manager (QAM)	<ul style="list-style-type: none"> • Approval of quality assurance project plan (QAPP) • Communication of quality assurance (QA) and quality control (QC) requirements to project personnel. • Provide guidance to the PM and/or task leader on QA/QC issues, as needed
Principle Investigators	<ul style="list-style-type: none"> • Contribute expertise to development of sampling design, EMP, QAPP, and final reports. • Lead field sampling and processing activities • Review laboratory data for reasonableness and usability.
Chief Scientist	<ul style="list-style-type: none"> • Ensures field sampling procedures comply with QAPP • Documents sample collection and processing activities, and initiates sample custody. • Maintain custody of field records during ship-board activities. • Review field records at the end of each sampling day.
Field Crew	<ul style="list-style-type: none"> • Collect the samples after the sampling equipment is retrieved • Take control of the collected samples once determined to be acceptable and maintain custody of samples collected for chemical analysis. • Process and preserve samples according to the QAPP • Prepare and ship samples under custody to the appropriate analytical laboratories
Laboratory Managers or Point of Contact	<ul style="list-style-type: none"> • Conduct all sample analysis, reporting, analytical activities, as well as all activities related to sample custody records and processing in accordance with their contracts and the QAPP and standard operating procedures (SOPs). • Review QC data, assign laboratory qualifiers, and implement corrective action • Contacting Laboratory Coordinator to communicate any issues that could affect sample integrity, data quality, or schedule. • Perform internal verification and validation of all reported data. • Ensure independent QA oversight • Submit data packages and electronic data deliverables (EDDs) that conform to QAPP requirements
Laboratory QA/QC Officer	<ul style="list-style-type: none"> • Review analytical data to verify that QAPP and SOP requirements were achieved • Ensure data are traceable to raw data, calculations are accurate • Ensure data qualifiers are applied to any data that do not meet the QAPP measurement quality objectives (MQO) requirements. • Report the results of audit to management

Role	Responsibilities
Vessel Master	<ul style="list-style-type: none"> Is the primary operator of the vessel In United States (US) waters, must comply with US Coast Guard (USCG), state, and local regulations Is responsible for all aspects of boating operations, regardless of any senior personnel present in the boat. These responsibilities include, but are not limited to: <ul style="list-style-type: none"> Safety of the vessel and all persons on board Safe transport of the vessel to and from her berth, if applicable The safe operation of all equipment Ensuring that all required operational and safety equipment is on board and that crew and passengers know the location and how to operate safety/survival equipment Report all accidents, incidents, boardings, citations, safety concerns according to USCG regulations

Notes:

EDD = electronic data deliverable
EMP = Environmental Monitoring Program
HSSE = Health, Safety, Security and Environment
MQO = measurement quality objectives
PL = Project Lead
PM = Project Manager
QA = quality assurance
USCG = U.S. Coast Guard

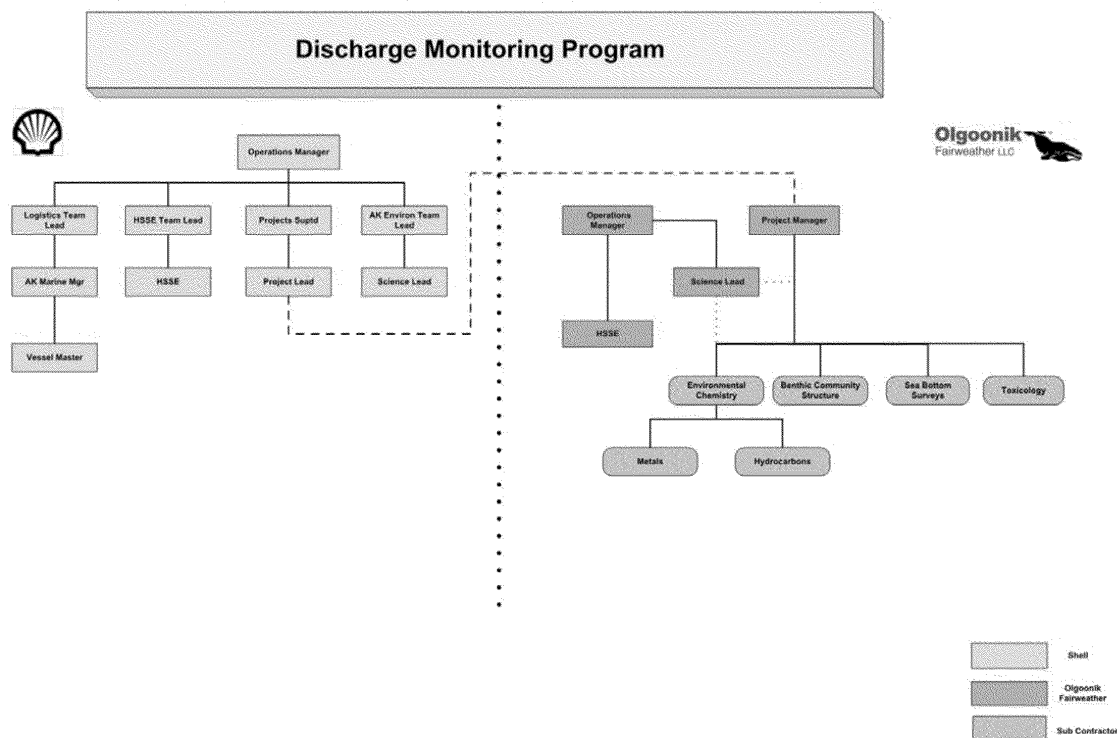
QAM = Quality Assurance Manager
QAPP = quality assurance project plan
QC = quality control
SL = Scientific Lead
SOP = standard operating procedure
US = United States

3.2.1 Project Organization

The reporting structure for the Chukchi Sea environmental monitoring plan is illustrated in Figure 3-1.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 94 of 174
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Figure 3-1 Organizational Structure for the Environmental Monitoring Plan Implementation Team



AKG-28-8100– Noble Discoverer
Revision 0, Effective Date May 2013

Page 95 of 174

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AKG-28-8100– Noble Discoverer
Revision 0, Effective Date May 2013

Page 96 of 174

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3.3 Data Quality Objectives

The data quality objectives of the EMP are to address the following National Pollutant Discharge Elimination System (NPDES) permit requirements:

- 1) Complete an initial site assessment, including a physical sea bottom survey, to ensure the exploratory facility is not located or anchored in a sensitive biological area or habitat;
- 2) Evaluate water-quality characteristics of the receiving water and potential effects of the specified discharges;
- 3) Evaluate sediment characteristics of the seafloor and potential effects of the discharges on the sediment characteristics;
- 4) Evaluate potential effects to the benthic community structure due to deposition of Discharge 001 (water-based drilling fluids and drill cuttings) and Discharge 013 (muds, cuttings, cement at the seafloor), which includes both spatial and temporal changes in community diversity and abundance; and
- 5) Evaluate the plume(s) in the vicinity of the discharges.

The sampling design described in Section 3.5 will address these objectives for each of the four phases defined in the permit. Table 3-2 summarizes the types of samples that may be collected.

Table 3-2 Summary of Field Sampling for the Four Monitoring Phases

Information Category	Matrix	Permit Reference	Existing Baseline Data (Phase I replacement) (pre-drill baseline) ¹	Phase II (during)	Phase III (post-drill)	Phase IV (no later than 15 months post drill)
Physical Oceanography/ Meteorology	Physical Characteristics (water)	II.A.f.2.	(X) ²			
	Plume Monitoring (water)	II.A.j.4		X		
Biology	Benthic Community Structure (benthos/epibenthos)	II.A.f.4 II.A.i.2	X			X
	Physical Sea Bottom Survey	II.A.f.1. II.A.h.1. II.A.i.1	X		X	X
Chemistry	Water-based Drilling Fluids/Drill Cuttings	II.A.j.1		X		
	Sediment Characteristics	II.A.j.2	X		X	X

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 97 of 174
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Information Category	Matrix	Permit Reference	Existing Baseline Data (Phase I replacement) (pre-drill baseline) ¹	Phase II (during)	Phase III (post-drill)	Phase IV (no later than 15 months post drill)
	(surface sediment)					
	Benthic Community Bioaccumulation Monitoring (tissue)	II.A.j.3	X		X	X
Chemistry (continued)	Receiving Water Chemistry	II.A.f.3.	(X) ³	X		
	Plume Monitoring (water)	II.A.j.4		X		

Notes:

¹ As indicated in the EMP, Appendix A, Phase I data includes historical data within the previous 5 years, sampling completed in 2012 and additional samples of opportunity to be completed during 2013, and samples that will be collected concurrent with Phase II.

² Water column physical characteristics will be collected during Phase II.

³ Reference samples will be collected outside the plume during Phase II as the most representative baseline (Phase I) data in open ocean water during drilling.

3.4 Sampling Design: Phase I through IV

The sampling design is based on and intended to meet the data quality objectives (DQOs) and the EMP, which requires environmental monitoring during four different phases (Phases I through IV; Table 3-3).

3.4.1 Phase I Assessments

The Phase I data collected from the previous 5 years was compiled and analyzed to determine the variability within and among the data sets from the same region and to establish whether historical data from a larger geographical area may be predictive of current baseline data at site-specific locations. The results demonstrate that baseline data are available and are sufficient for replacement of Phase I permit requirements; therefore, Phase I sampling requirements are not addressed in this QAPP. The results of this analysis are presented in the EMP; Appendix A. Shell may collect samples of opportunity during the 2013 field season.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 98 of 174
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Table 3-3 Summary of Analytical Parameters by Matrix

Parameter Class	Water Total	Water Particulate	Water Dissolved	Sediment	Tissue	Drilling Fluids/Cuttings¹
Volatile Organic Carbon (VOC)/ Total Aromatic Hydrocarbons (TAH) ^{2,3}	(Phase II) ⁴					Phase II
Saturated Hydrocarbons (SHC)	(Phase II)			Phase III Phase IV	Phase III Phase IV	Phase II
Total Petroleum Hydrocarbons (TPH)	(Phase II)			Phase III Phase IV	Phase III Phase IV	Phase II
Polycyclic Aromatic Hydrocarbons (PAH)	(Phase II)			Phase III Phase IV	Phase III Phase IV	Phase II
Biomarkers				Phase III Phase IV	Phase III Phase IV	Phase II
Percent Lipid					Phase III Phase IV	
Particulate Organic Carbon (POC)	(Phase II)					
Total suspended solids (TSS)	(Phase II)					
Grain Size				Phase III Phase IV		
Total organic carbon (TOC)				Phase III Phase IV		
Sediment profile imaging (Sea Bottom)				Phase III Phase IV		
Benthic Community Structure (benthos/epibenthos)				Phase IV		

AKG-28-8100– Noble Discoverer
Revision 0, Effective Date May 2013

Page 99 of 174

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*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

Parameter Class	Water Total	Water Particulate	Water Dissolved	Sediment	Tissue	Drilling Fluids/Cuttings ¹
Aluminum (Al)		Phase II		Phase III Phase IV	Phase III Phase IV	Phase II
Antimony (Sb)		Phase II		Phase III Phase IV	Phase III Phase IV	Phase II
Arsenic (As)			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Barium (Ba)		Phase II	Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Beryllium (Be)				Phase III Phase IV	Phase III Phase IV	Phase II
Cadmium (Cd)			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Chromium (Cr)		Phase II	Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Copper (Cu)			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Iron (Fe)		Phase II		Phase III Phase IV	Phase III Phase IV	Phase II
Lead (Pb)			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Mercury (Hg)			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Methyl mercury			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 100 of 174
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*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

Parameter Class	Water Total	Water Particulate	Water Dissolved	Sediment	Tissue	Drilling Fluids/Cuttings ¹
Nickel (Ni)			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Selenium (Se)			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Silver (Ag)				Phase III Phase IV	Phase III Phase IV	Phase II
Tin (Sn)			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Titanium (Ti)				Phase III Phase IV	Phase III Phase IV	Phase II
Thallium (Tl)			Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Zinc (Zn)		Phase II	Phase II	Phase III Phase IV	Phase III Phase IV	Phase II
Total metals		6	13	19	19	19

Notes:

¹ Analyses for total recoverable [metals] concentrations must be conducted and reported for each metal using method specified in 40 CFR Part 136. The results must be reported in “mg/kg of whole mud (dry weight) and moisture content (percent by weight) of the original drilling fluid sample.”

² TAH “as determined by EPA Method 602 (plus xylenes)”.

³ Total Aqueous hydrocarbons (TAQH) is the sum of TAH + PAH.

⁴ As indicated in the EMP, Appendix A, Phase I data includes historical data, sampling completed in 2012, additional samples of opportunity to be collected during 2013, and samples that will be collected concurrent with Phase II.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 101 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 102 of 174
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3.4.2 Phase II Plume Monitoring and Observations

The Phase II sampling period is defined in the permit as the “during drilling” sampling. Plume monitoring will be conducted during the maximum discharge period correlated with areas of expected deposition of muds and cuttings (001) based on model predictions. Phase II sampling consists of collecting water samples for chemical and physical analyses.

The following time points during drilling will be targeted to capture the “maximum discharge periods” and periods representing different types of discharge (i.e., potentially different physical and chemical composition of the discharge):

- 1) Largest Casing interval (beyond top-hole);
- 2) Hydrocarbon zone; and
- 3) Bulk-mud discharge

During the three discharge events listed above, seven sampling stations will be targeted for sample collection (Figure 3-2). A total of 105 water samples will be targeted for collection plus 12 samples of drill cuttings and drilling mud will be collected during Phase II (Table 3-4). Current measurements will be measured with the ADCP system and will be used to inform actual sampling stations during field activities.

The data collected during the Phase II monitoring will be used to assess the location of the plume(s), to refine model inputs, and to help inform the Phase III and IV monitoring efforts.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 103 of 174
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Figure 3-2 Phase II Water Sampling Stations

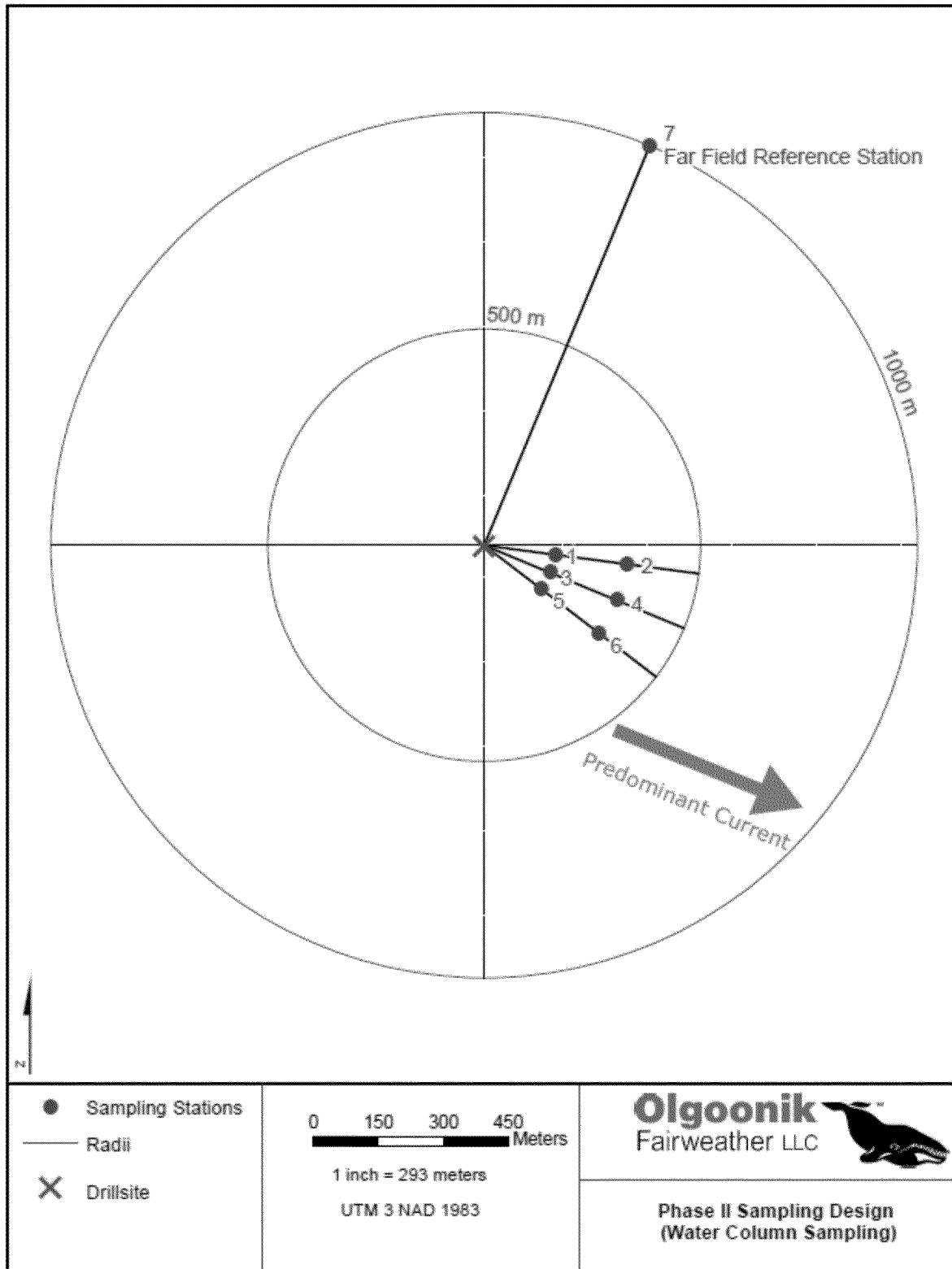


Table 3-4 Number of Samples Slated for Collection During Phase II

Sampling Water Depth ¹	Transect Type	Well Timing – Largest Casing Interval	Well Timing – Hydrocarbon Zone	Well Timing – Bulk Muds	Total Number of Samples
1 m below surface	Plume	6	6	6	18
	Reference	1	1	1	3
10 m below surface	Plume	6	6	6	18
	Reference	1	1	1	3
20 m below surface	Plume	6	6	6	18
	Reference	1	1	1	3
30 m below surface	Plume	6	6	6	18
	Reference	1	1	1	3
2 m above sea bottom	Plume	6	6	6	18
	Reference	1	1	1	3
Drilling Cuttings	Drilling Rig	2	2	2	6
Drilling Mud	Drilling Rig	2	2	2	6
Subtotal for each well-trimming component		39	39	39	117

Notes:

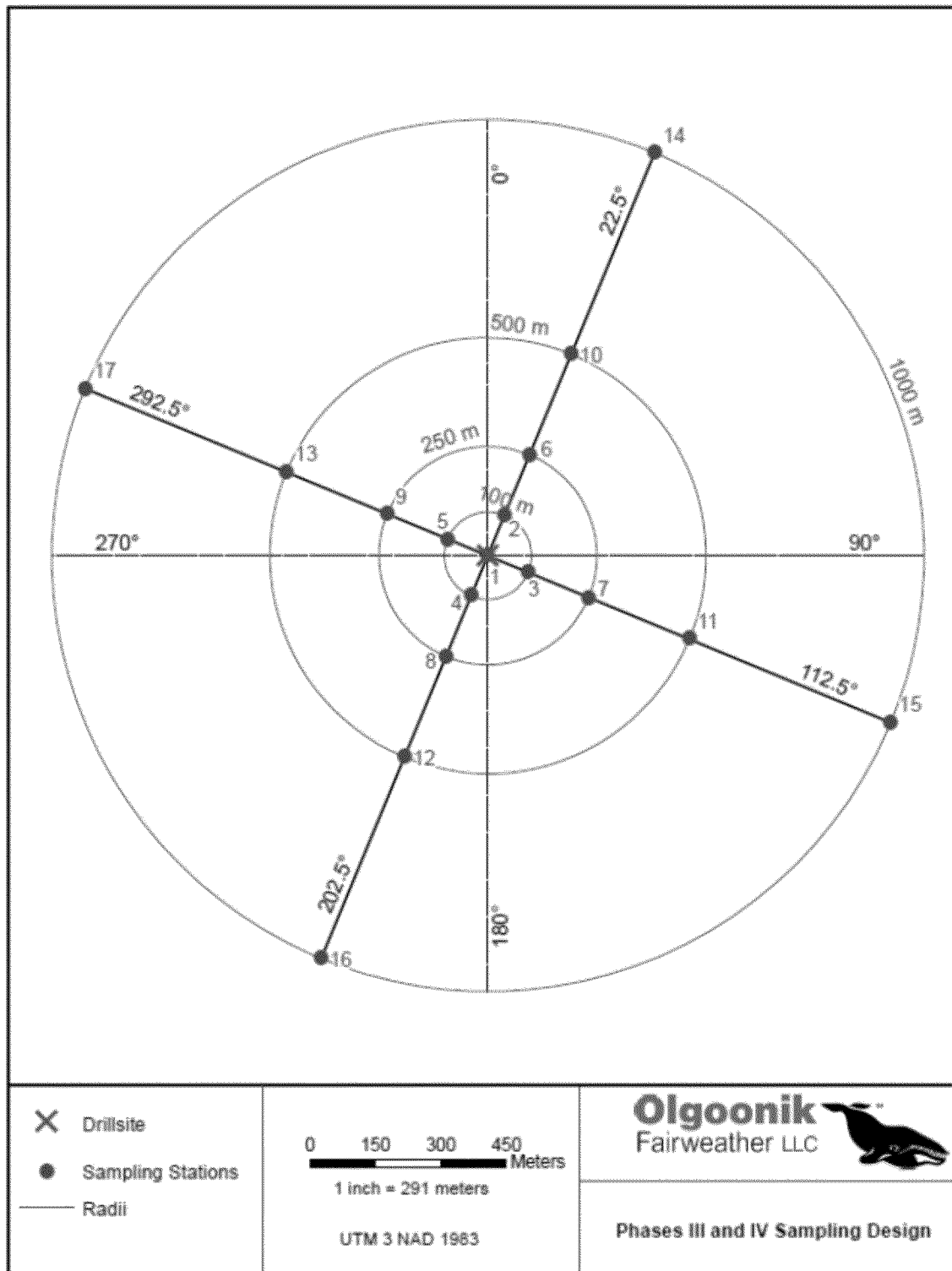
¹ Sampling water depth may vary depending on in-field measurements of turbidity during plume monitoring.

3.4.3 Phase III Assessment

Phase III incorporates the post drill sampling immediately (as soon as practicable) following cessation of drilling at a well site. “In the event that unforeseen circumstances occur preventing the environmental sampling of data immediately after drilling”, the EPA will be notified immediately to determine the next course of action A four-transect design (N, E, S, and W) oriented/rotated approximately 22.5° to the east of north to allow for sampling along the mean current direction, in conjunction with four different radii at 100 m, 250 m, 500 m, and 1000 m from the drill site location, will be used (Figure 3-3; Table 3-5).

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 105 of 174
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Figure 3-3 Phase III and IV Sampling Stations



These transect orientations may be modified in the field, depending on observations made during the field effort (e.g., the Phase II ADCP data indicate a different trajectory for the predominant downstream current direction and/or Sediment Profile Imagery and grab samples that indicate the deposition of muds and cuttings).

Table 3-5 Summary of Near-Field¹ Phase III and IV Samples Slated for Collection

Discipline	Number of stations	Number of samples
Sediment Profile Imagery	17	17
Benthic ecology (Phase IV only)	17	85 (5 reps)
Chemistry—sediments	17	17
Chemistry—biota (clams)	4	4

Notes:

¹ Far-field samples will be collected at 2-4 stations contemporaneous with the near-field stations and locations will be determined in the field.

3.4.4 Phase IV Assessment

The sampling that occurs for the Phase IV monitoring must follow the same sampling design as for the Phase III sampling, as per the NPDES permit (Figure 3-3; Table 3-5). Sediment profile imaging (or similar technology), sediment chemistry, and tissue chemistry sample collection for Phase IV will be identical to the Phase III sampling design. Benthic community structure will be added for the Phase IV assessment to measure and assess any potential long term impacts to the benthic community as a result of the exploratory drilling operations. Five replicate sediment samples for identification and enumeration of benthic infauna will be collected from all 17 stations.

3.5 Field Sampling

3.5.1 Sampling Methods

The following section summarizes the field sampling procedures that will be used to implement the environmental monitoring plan. Details are provided in field SOPs provided in Attachment A.

3.5.1.1 Navigation

The Shell vessel navigation system will be used to track vessel and sampling locations during environmental monitoring if the accuracy of the system meets the EMP requirements (± 10 m). If the vessel navigation system cannot meet this level of accuracy, an auxiliary system will be provided to define sampling locations. The location of each sample is marked as milestone when the sampling team communicates that a sample is about to be collected. The milestone number is documented in the field log and the pre-assigned sample identification (ID) number is communicated to the navigator and recorded with the milestone number, creating a link between each sample and the station coordinates.

3.5.1.2 Protected Species Observers

Shell operates an extensive integrated marine mammal monitoring program in compliance with the Marine Mammal Protection Act (MMPA) during all exploration activities. In accordance with the MMPA, applicants for an Incidental Harassment Authorization (IHA) from the trustee agencies, i.e., National Marine Fisheries Service and U.S. Fish and Wildlife Service, are required to provide a

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 107 of 174
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monitoring and mitigation plan. The agencies evaluate these plans through a process of independent peer review and public review prior to authorizing proposed activities. Although the IHA that will cover proposed 2014 drilling operations along with the associated monitoring program is not yet available, it is anticipated that the monitoring program will be effectively the same as the one implemented in 2012. A full description of this program and its results can be found at http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_90dayreport_draft2012.pdf.

In summary, the Shell monitoring and mitigation program includes three integrated components:

1. A vessel-based observer program under which protected species observers (PSOs) on all vessels maintain watch for marine mammals. These PSOs have dual duties to implement any needed avoidance or mitigation measures and to record data on observations, including species, location, activity, orientation toward drilling activities, etc.;
2. An aerial based observer program under which PSOs fly over the area of the drilling activities and observe and record data on marine mammals; and
3. An acoustic program under which industry sounds and marine mammal calls are recorded and can be analyzed for distribution and reaction to drilling related activities.

This integrated program will provide a good understanding of the relative distribution of marine mammals in proximity and relation to the drilling related activities, the relative amount of time individuals may be within an area of potential exposure, and the portion of the population of each species that could potentially be within a range of exposure to drilling related effluents. The non-contact cooling water discharge (009) is the driver for marine mammal monitoring during drilling. However, thermal dispersion modeling indicates no significant impact on ambient water quality in the vicinity of the drill rig. The maximum plume depth derived from the model is 3 m. The maximum plume width is 15 m, and the maximum thermal plume duration is 30 minutes. The maximum area affected is 45 m² (EMP; Appendix C).

3.5.1.3 Acoustic Doppler Current Profiler (ADCP)

The subsurface ADCP or similar technology will be positioned no more than 2000 m from the drill site. The data on current speed and direction will be relayed in real-time or near-real time fashion from the units to the vessel so that the field team can use them to maximize the effectiveness of the Phase II plume-sampling component. The current data will provide an estimate of the trajectory of the plume in the field. Discrete water samples then will be collected from the sampling stations.

3.5.1.4 Conductivity, Temperature, and Depth (CTD)

A Sea-Bird Electronics, Inc., SBE19*plus* V2 (or similar) CTD profiler with an optical backscatter turbidity sensor (OBS), two turbidity sensors and transmissometer will provide real-time multi-dimensional data on suspended solids to optimize water-sampling locations. The CTD will be mounted on the rosette water sampler and used to collect hydrographic data at each water station.

Sensor measurements will be collected during the downcast from near surface (approximately 1 meter) to within approximately 2 m of the sea floor at each station. Salinity and density (as sigma-t) will be calculated using Sea-Bird software from the conductivity, temperature and depth data. Navigational position and time will be recorded concurrently with the hydrocast measurements. CTD profiles and the

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 108 of 174
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presence of suspended solids detected by the turbidity sensors, OBS and transmissometer will indicate the presence of the plume in addition to ADCP data and real-time weather conditions. Water samples will be collected during the upcast within the depth zones indicating plume characteristics. CTD operation will follow the guidance of SOP 5-275 *At-Sea Collection of Hydrographic Data Using CTD and Rosette System*.

3.5.1.5 Water Samples

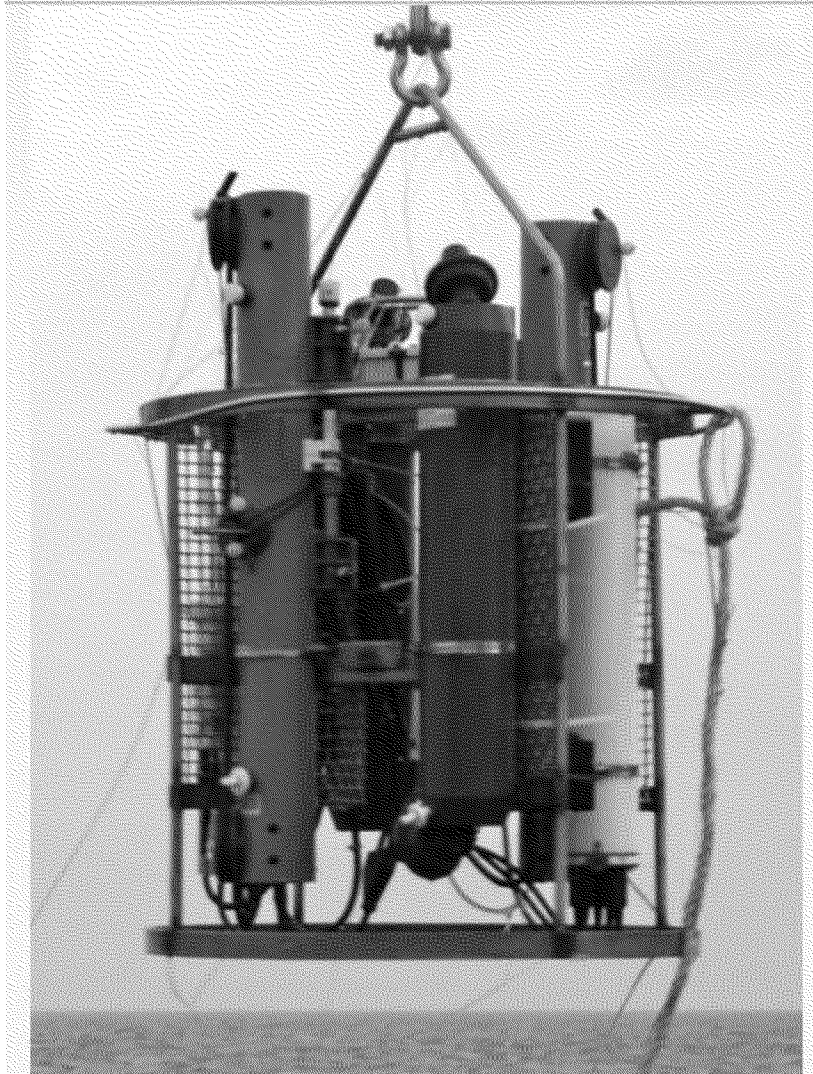
A total of 105 water samples at five different depths in the water-column will be targeted for collection during Phase II using six-bottle rosette sampler (Figure 3-4). Samples will be collected in the rosette GO-FLO or Niskin bottles. The sampling layout is depicted in Figure 3-2. Table 3-4 summarized the sampling design. Sampling collection using the rosette sampler will follow the guidance of SOP 5-275 *At-Sea Collection of Hydrographic Data Using CTD and Rosette System*.

Transect locations will maximize the plume coverage in response to discharge and plume dynamics. The general procedure during each sampling event is proposed as follows:

- 1) The field team will use the real-time or near-real time ADCP data (if available) to determine the current direction and speed near the drilling operation.
- 2) Prior to initiation of plume tracking, whole-water samples and CTD/turbidity data will be collected along the reference transect located at least 1,000 m away and perpendicular to the northern end of the downstream plume transect (Figure 3-2, Station #7).
- 3) The plume-monitoring transect will be conducted across the plume (laterally) at intervals from as close to the release point as it is safe to proceed and down-current until evidence of the plume (e.g., turbidity measurements above background levels) disappears (Figure 3-2). ADCP data will be used to help locate the plume vertically and horizontally based on water volume velocity data. Modifications to the transect scheme may be made at the discretion of the field leader in response to conditions encountered in the field.
- 4) Additional vessel transects along the plume (axially) may be made at the discretion of the field leader to help locate plume boundaries, pending vessel logistical considerations and priorities in the field.
- 5) Whole-water samples will be collected with a sampling rosette within the plume at six stations along three transects (two stations per transect) oriented in the direction of the predominant current at each of five depths. The three plume transects will be separated by approximately 10-15 degrees from the source. All plume-transect sampling stations will be located within 500 m from the drilling location, with the near-field stations being as close to the discharge as logistically possible.
- 6) ADCP and CTD data will be used in an adaptive manner to optimize the location and depth for discrete water sample collection to capture the densest portion of the plume when possible. General target sample depths are approximately 1 m (near-surface), 10 m, 20 m, 30 m below the surface of the water, and 2 m above the sea bottom.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 109 of 174
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Figure 3-4 Rosette Water Sampler with Go-Flow Bottles and CTD Sensors



3.5.1.6 Muds and Cuttings

Two samples of used water-based mud (WBM) and two samples of drill cuttings will be collected during three intervals of the drilling in Phase II of the monitoring program (Table 3-4) for a total of 12 samples. Drilling-mud compositions and monitoring records will be obtained from the drill-rig supervisor to the degree possible.

The WBM and drill cuttings will be collected by personnel on the Shell drilling rig (e.g., M-I SWACO Compliance Specialists), placed in clean glass jars, and provided to the Field Leader for handling according to Section 3.5.2.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 110 of 174
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3.5.1.7 Sediment Samples

Sediments will be sampled at 17 stations during Phases III and IV with a double van Veen grab sampler (Table 3-5). Samples will be collected from the top 2 cm (i.e., the surficial layer) of sediment. Depending on sediment observations from van Veen grab collections, gravity-core samples also may be collected in the field to obtain truly undisturbed cross-sectional samples of the sediment layer and to provide information on “the areal extent and depth/thickness of solids deposition caused by Discharges 001 and 013.”

Van Veen Grab Sampler

The double Van Veen grab sampler is designed to be deployed from a vessel equipped with a power winch and A-frame or boom system and to collect undisturbed surface sediment samples to a maximal depth of approximately 30 cm. The double-van Veen grab sampler enables chemistry and benthic infaunal samples to be co-collected from the same deployment. Fairweather Science (FWS) SOP 06 *Surface Sediment Sampling Using a Modified Van Veen Grab Sampler* describes the operation of the grab sampler. Based on the sediment surface, the penetration depth of the grab sampler will be modified for softer or denser sediments. Weight can be added for dense, stiff sediment or can be removed for soft sediments. In addition, plywood boards can be cable-tied to the grab to slow the descent rate into the sediment.

Upon return of the grab sampler to the deck of the vessel, the grab will be placed on a sturdy table to allow for sample collection from the buckets. The hinged access doors on the top of the grab are opened to determine whether the sample is acceptable for collecting material for analysis. An acceptable grab is one that displays the following characteristics:

- Sampler is not overfilled with sediment, the jaws are fully closed and the top of the sediment is below the level of the open doors.
- Overlying water must be present and must not be excessively turbid.
- The sampler is at least 80% full of sediment, indicating that the desired penetration has been achieved.
- The sediment is level on at least one side.

Overlying water indicates that the sediment sample is undisturbed and that surface sediments remain intact (i.e., there was no leakage of water and, hence, fine sediment from the grab). If the grab is unacceptable, the grab sampler will be redeployed at a slightly different location to avoid disturbance of the sediment layer from previous unacceptable grabs and drops of unwanted sediment.

If the grab sample is acceptable then samples will be collected as follows:

- 1) Remove overlying water from the grab by siphoning through a pre-cleaned Teflon tube. (See Section 3.5.1.11 for equipment decontamination procedures).
- 2) Collect samples through the access doors into stainless steel bowls, avoiding sediment that contacts the metal sides of the grab.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 111 of 174
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- 3) Collect the top 2 cm of sediment in the grab using a Kynar® (or equivalent)-coated scoop pre-marked with a 2-cm marking. This surficial sediment layer represents recent accumulation (in this case, potentially drilling muds and cuttings discharged as a result of the drilling operations).

Once the top 2 cm have been removed from the grab into a stainless steel bowl, it will be gently but thoroughly mixed to a homogeneous color and consistency and subsampled into the appropriate containers for analysis of organics, metals, grain size, and total organic carbon (See Table 3-6).

Gravity Core

If collected, the sediment-core samples would be obtained most likely in the immediate vicinity of the drilling location and at the stations located within the downstream 100-m and 250-m concentric radii from the drill site. If evidence exists in the field of muds or cuttings thicker than expected beyond the 100-m radii, additional core samples may be taken. This decision about additional coring will be made at the discretion of the field team leads. In the event that additional coring occurs, the sediment-core samples will replace the van Veen grab samples at those station location(s). These samples would be collected only if/when sediment samples collected by grab indicated substantial thickness of drilling muds or cuttings.

SOP 5-342 *Collecting Sediment Cores with a Piston Push/Hammer Corer* describes the operation of the gravity core. After collection, the core liner with sediment will be removed from the outer core tube. Following penetration and removal, the core will be examined for integrity and volume. The core is acceptable if the appropriate length is collected and the sediment recovered is relatively undisturbed throughout its depth. Disturbed cores will be rejected; a new core liner installed; and the station will be resampled. If not immediately processed, the core liner will be sealed at each end with electrical tape or an equivalent system (e.g. cable tie) and stored upright in ice for up to 6 hours prior to processing. Pre-cleaned core liners will be used to collect each sample; a new liner will be used for each station. The cores must be chilled (Table 3-6) and stored upright until processing.

Core sample processing will be conducted in the field on the vessel as follows:

- 1) Place the core liner with sediment onto a clean working surface.
- 2) Cut the core liner length-wise with a clean stainless steel knife.
- 3) Split the core length-wise using a clean stainless steel knife and/or spatula
- 4) Gently open the two halves and remove any pieces of liner material in contact with sediment.
- 5) Collect the sediment in each core segment using a pre-cleaned stainless steel or Kynar® (or equivalent) coated spoon or spatula into a clean stainless steel bowl. The length of each core segment will be “adaptively managed” based on observed horizons identified by the Field Lead. It is anticipated that segments could range from 2 – 10 cm.
- 6) Gently but thoroughly mix the sediment to a homogeneous color and consistency and subsampled into the appropriate containers for analysis of organics, metals, grain size, and total organic carbon (See Table 3-6).

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 112 of 174
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Table 3-6 Sample Containers, Sample Sizes, Preservative Requirements, and Holding Times

Compound Class	Minimum Sample Size	Container ¹	Preservation	Holding Time ²
Sediment/WBM/Cuttings				
Hydrocarbons ³	8oz	Glass with Teflon lid	Frozen –20°C	1 year to extraction/40 days to analysis
VOC, muds and cuttings only	10g	Glass with Teflon lid	Cool <6°C	14 days
Metals	2oz	Glass with Teflon lid	Frozen –20°C	1 year
Mercury	4oz (1/2 filled)	Glass with Teflon lid	Frozen –20°C	1 year
Methylmercury	4oz (1/2 filled)	Glass with Teflon	Frozen –20°C	1 year
TOC	2 oz	Glass	Cool <6°C, above freezing	28 days
Grain Size	2 qt	Ziploc bag	Cool <6°C, above freezing	6 months
Benthic Animals	60ml	Plastic	Buffered Formalin	1 month
Tissue				
Hydrocarbons	8oz	Glass with Teflon	Frozen –20 °C	1 year to extraction/40 days to analysis
Metals	2oz	Glass with Teflon	Frozen –20 °C	1 year
Mercury	4oz	Glass with Teflon	Frozen –20 °C	1 year
Methylmercury	4oz	Glass with Teflon	Frozen –20 °C	1 year
Water				
VOC ⁴	3 x 40 ml vials	Glass with Teflon-lined lid	No head space. Acidified to a pH ≤2 with hydrochloric acid, above freezing	14 days
Hydrocarbons ⁵	2 l L	Glass with Teflon-lined lid	Cool <6°C, above freezing	14 days to extraction/40 days to analysis
Metals (dissolved)	1L	Glass with Teflon-lined lid or HDPE	Acidified to a pH ≤2 with Nitric Acid	6 months
Metals (particulate filter)	1 mg on filter ⁶	Plastic petri dish; double Ziploc bags	Dry	6 months
Mercury	0.5 L	Teflon	Acidified to a pH <2 with Hydrochloric Acid	90 days
Methylmercury	0.5 L	Glass with Teflon-lined lid	Acidified to a pH <2 with Hydrochloric Acid	180 days
AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013				Page 113 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.				

Compound Class	Minimum Sample Size	Container ¹	Preservation	Holding Time ²
POC	1	Glass Fiber filter in plastic petri dish	Frozen	1 year
TSS	1	Polycarbonate Filter	Frozen in sealed petri dish	6 months

Notes:

¹ Container Types: G = Glass/Teflon-lined lid; P=Plastic SPEX.

² "x" days/"y" days = maximum days from sampling to extraction/maximum days from extraction to analysis.

³ PAH, SHC/TPH, petroleum biomarkers.

⁴ Three 40-ml VOC vials w/ Teflon® septum and Zero head space.

⁵ PAH, SHC/TPH

⁶ Volume filtered based on the TSS concentration; typically 0.5 – 2.0 L.

3.5.1.8 Sediment Samples - Benthic Ecology Samples

Benthic invertebrate sampling will occur, as per permit requirements, in Phase IV (“no later than 15 months after drilling operations cease at a drilling site”). Infauna (invertebrate animals residing within the sediments) will be collected with a van Veen grab sampler (0.1 m² surface area) and then sieved through a 1.0-mm-mesh (the standard for investigations in Alaska with fine sediments) and a 0.5-mm mesh (to be archived for potential evaluation of smaller or juvenile organisms) screens. Five replicate samples will be collected at each of 17 stations for a total of 85 samples (Table 3-5). Every effort will be made to use only grabs that have demonstrated no wash-out of the sediment surface. Except under extenuating circumstances, van Veen grabs should be full. Low-volume grabs should be rejected for community-composition samples. Samples will be carefully dropped into buckets and transported and poured into the sieves without spillage. A substantial spillage will require a new sample. Samples will be rinsed over a nested 1.0-mm-mesh and 0.5-mm mesh screens with water pressure sufficient enough to remove sediments but weak enough to minimize damage to the animals. Rinse water should be seawater filtered at least as low as the smallest sieve. This is to remove any indigenous pelagic organisms that may be introduced into the benthic sample. Biological and sediment residues will be carefully removed from the sieve so that all visible animals, sediment particles, and fragments will be removed. The biological and sediment residue remaining in each sieve will be placed into separate pre-labeled plastic jars or Whirl Pack bags, preserved in 10% formalin buffered with borax or equivalent, and securely stored for shipment to the laboratory. Detailed procedures for benthic sample collection and processing are provided in SOP SAM043.01.

3.5.1.9 Tissue Samples for Chemistry

Collection of biota samples will be attempted at four (4) stations each during both Phases III and IV (Table 3-5). Target locations for clam sampling will be stations 3, 7, 11, and 15 but the actual locations will be determined in the field based on the availability of clams. The target species will be bivalves or other fleshy organisms that could uptake contaminants through filter feeding or direct contact with sediment. Bivalves are the target biota type, but if not present in adequate numbers at the time of sample, collection of alternative organisms such as amphipods may be attempted. Due to natural patchiness of the biota, it is unlikely that biota samples will be able to be collected at all stations. Biota samples for tissue analysis will be collected by using a combination of a clam rake and double van Veen grab sampler at the same station. Previous efforts at collecting bivalves and other benthic organisms in the Chukchi Sea (J.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 114 of 174
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Hardin, Battelle, San Diego, CA, pers. obs.) indicated that clams are not obtained in large numbers (i.e., large enough for tissue volumes required for chemical analyses) with the double-van Veen grab sampler. However, the use of a clam rake towed for a few minutes typically allows for collection of numerous bivalves. Because sample size is important for chemical analysis (i.e., having enough sample volume for all analyses), the use of the clam rake is warranted for bivalve collection. FWS SOP-12 *Benthic Tissue Sampling for Chemical Analysis Using a Dredge/Rake* and FWS SOP-13 *Amphipod Sampling for Chemical Analysis Using a Modified Minnow Trap* describe the collection procedures.

Following tissue sample collection, the catch is brought aboard and emptied into large plastic tubs. The contents of the tubs then are sorted by trained personnel using either clean-gloved hands or clean-gloved hands and pre-cleaned stainless-steel forceps. Target bivalve species include *Astarte* spp. and *Macoma* spp. If numbers are sufficient, one and the same species will be collected at each station; however, if this is not possible then it is more important to collect sufficient tissue for analysis. Preliminary identification of the bivalve species will be determined in the field and verified by taxonomic identification in the Benthic Ecology Task. Collected bivalves are placed in a clean sieve and gently rinsed with seawater to remove external debris prior to being counted and photographed. Clams placed into pre-cleaned glass containers, and frozen (Table 3-6).

3.5.1.10 Sediment Profile Imaging

Plan-view digital photographs of the seabed and/or profile digital photographs of the sediment–water interface will be obtained with sediment profile imaging (SPI) technology and/or other similar technology, such as a camera-sled or remotely operated vehicle (ROV). These will be used to monitor the physical and benthic-infaunal characteristics in surface sediments (10–20 cm) in the study area after exploratory drilling is completed (Phase III and IV). SPI will be conducted at the stations depicted in Figure 3-3. If real-time assessment of the images in the field suggests a steep gradient between sites with noticeable deposition and sites with no visual signs of disturbance, the system will be deployed between the predetermined locations based on best professional judgment in the field in conjunction with logistical factors such as other sampling priorities and weather conditions. Operation of the SPI will follow the guidance of SAM044.01.

The SPI system consists of a camera enclosed in a waterproof, pressure-resistant housing, a 45° prism that penetrates the sediment, and a mirror that reflects an image of the sediment profile through the camera lens to a digital camera (Figure 3-5). The camera frame also supports a downward-looking camera to view the surface of the seabed. These images are viewed onboard the vessel after the system has been retrieved and permit the scientific crew to view conditions of the seabed and the ability to provide near real-time guidance of sampling activities and strategy. The two independent camera systems are triggered by mechanical switches. The plan-view camera is triggered first at a pre-determined elevation above the sea bottom. When the system hits the sea bottom and the prism begins to penetrate the sediment, the SPI camera switch initiates time delay electronics that trigger the camera to collect an image and the prism has completed penetration (~15 seconds). At each station, the camera is lowered to the sea-floor at least three times to ensure that replicate images suitable for analysis are obtained. At any station where difficulties are encountered, additional camera drops can be made. The date, time, station, water depth, photo number, and estimated prism penetration are recorded in a field log, with each drop of the camera also marked as an event within the navigation system. The digital images are transferred to an onboard

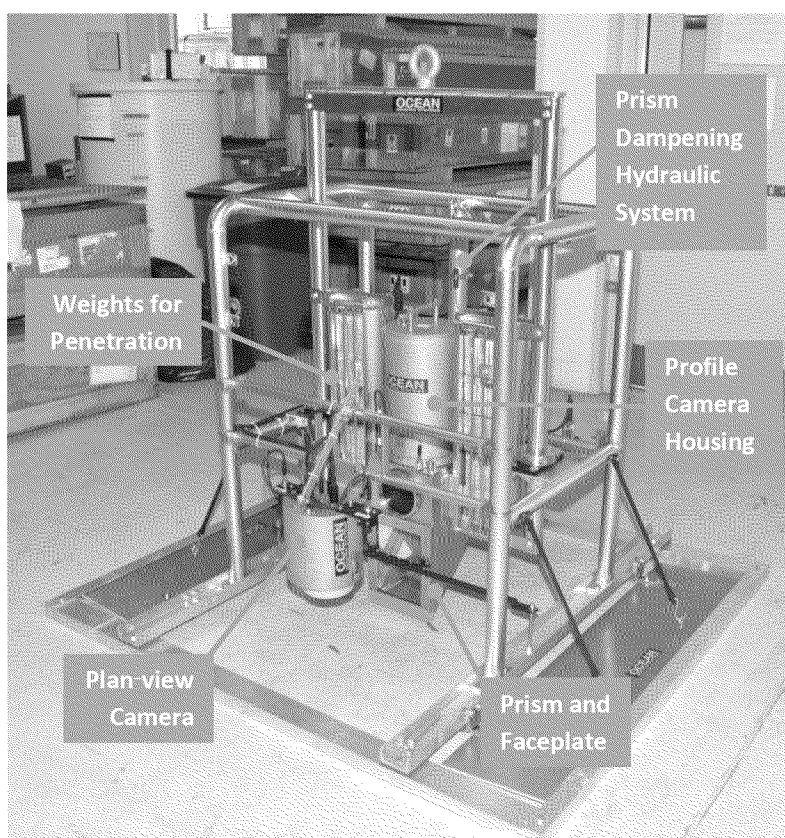
AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 115 of 174
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computer after each station for back-up. Images are transferred to a third location (e.g., an external hard drive) at least 1 time/day.

The plan-view system is a downward looking camera attached to the front of the frame with a strobe attached to the back of the frame (strobe is not seen in Figure 3-5) that collects an image of the seabed surface before the frame has settled on the sea bottom. The SPI camera provides a cross sectional sideways view of the sediment and the plan-view camera provides a horizontal view of surface details. The plan-view camera depicts large infaunal (e.g., tubes of burrowing worms) and epifaunal organisms (e.g., sea stars, crabs, snails).

The vertical cross-section SPI images, combined with the downward-looking horizontal images, provide a “quick look” analysis of conditions during and immediately after completing the field work. Parameters that can be evaluated in the quick-look analysis are general sediment grain size; sediment layering, layer thickness, and sediment type; surface and subsurface fauna and structures; approximate prism penetration; approximate surface relief; color and depth of the apparent redox potential discontinuity (SPI RPD); general benthic successional stage; and other major readily discernible patterns, including deposits of cuttings.

Figure 3-5 Sediment Profile Imaging and Plan View Camera Systems



AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 116 of 174
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Extreme care will be taken to avoid cross-contamination of sampling equipment and samples during collection and processing. FWS SOP-04 *Decontamination of Equipment – Sediment* and FWS SOP-07 *Decontamination of Tissue Sampling Equipment* describes general procedures for decontamination of field sampling equipment. Other procedures include the following:

- Avoid contact with hydrocarbon sources and any possible metals contamination during the collection of samples.
- Use only clean stainless steel metal equipment and utensils for sample collection.
- Decontaminate all components of the sampling equipment prior to use.
- Store sampling equipment away from grease drips from winches and winch wire, diesel smoke, and other potential airborne contaminants (e.g., smoking) when it is not being used to sample.
- Process samples in a clean area outside the influence of gasoline or diesel engines fumes and exhaust gases.

Rigorous decontamination procedures will be used to ensure that sampling equipment is clean.

To the extent possible, non-contaminating, pre-cleaned materials (glass, stainless steel, Teflon™) will be used for sample collection. When this is not possible (steel equipment, core liners), the sampling equipment will be cleaned as described below; 1% Alconox® solution (or equivalent) will be used as soap. The use of solvents as part of the equipment decontamination process will be avoided, if possible, to limit the generation of solvent waste. However, if any oily sheen is noted or if oil contamination is suspected then the affected equipment will be rinsed three times with methanol. The methanol must be completely evaporated prior to use of the equipment.

- Any utensils that will contact samples for chemical analysis (e.g., stainless steel spoons or spatulas, screens and forceps) will be scrubbed with soap and water and rinsed three times with deionized water rinse.
- During the sample collection and processing, field personnel will wear nitrile (or equivalent) gloves that will be changed between stations.
- Sample coring equipment will be cleaned prior to use and between samples. A new core liner will be used for each station. Other components of the core will be thoroughly scrubbed with a stiff brush and soapy water and thoroughly rinsed with site water at the beginning of each day and between each sampling station.
- All sources of contamination (airborne sources, fingers, unclean equipment) should be avoided.
- The core liner will be sealed at both ends to contain the sediment and keep contamination out. The core sample will not be removed from the liner until it is ready for processing under controlled conditions.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 117 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

3.5.2 Sample Handling and Custody

The procedures described in this section are designed to ensure that sample integrity and custody are maintained at all times. If the sampling labeling, preservation, holding times, or custody requirements are not met, the client will be notified. The laboratory may proceed with testing with client approval and the data will be qualified by including a discussion of any protocol deviations in the analysis report. If deemed feasible, the client may elect to provide a replacement sample for the out-of-specification sample and the initial sample rejected for further testing.

3.5.2.1 Sample Labeling

A unique sample identification (ID) number must be assigned to each sample. The sample ID must be documented in the field logbook and communicated to the ship navigation system so that sample location and collection information are definitively linked to a specific sample container. The sample ID is a concatenation of the sample year, station ID, replicate number, and sample type in the form as shown in Table 3-7.

Table 3-7 Sample Identification Scheme

Character Position in Sample ID	Description	Example
1,2	Year	13 (i.e., 2013)
3-8	Station ID	BA001a
9,10	Replicate Number	01
11,12	Sample Type	SC, LC
13,14	Visit Number	01
Sample Identification Code Definitions		
Codes for Sample Types	QC Sample Types	Visit Number
SC = Sediment chemistry WC = Worm chemistry LC = Water (liquids) chemistry DC = Drilling fluid chemistry CC = Cuttings chemistry SP = Sediment Profile Imagery photograph PV = Sediment Profile Imagery plan view camera photograph BI = Benthic infauna	EB = Equipment blank FB = Field blank DU = Field duplicate TB = Trip blank	A unique sample ID if re-sampling is needed. The default is 01, and is incremented each time a sample is recollected.

Each sample must be labeled with the unique sample identification number as soon as it is containerized. Sample labels must provide sufficient detail to uniquely identify each sediment sample and allow tracking to field activities. An example label is shown in Figure 3-6.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 118 of 174
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Figure 3-6 Example Sample Label

Project <u>Chukchi Sea</u>	Sample ID _____
Collection Date (YYMMDD) _____	Time (2400) _____ Station ID _____
Matrix (Circle one): Sediment / Water / Tissue / Drilling Fluid / Cuttings	
Water Type (Circle one): Whole / Particulates / Dissolved	
Tissue Type (Circle one or enter other): Macoma / Astarte / Other: _____	
Analysis Type: Organics Metals POC TSS TOC Grain size Biology	
Preservation (Circle): Chill Freeze Acidify Formalin None Other _____	
Sample Collector Initials: _____	
Container ____ of ____ (e.g., 1 of 2, 2 of 2) if the sample is contained in more than one container.	

3.5.2.2 Sample Preservation and Packing for Shipment

Once samples are aliquoted to sample containers for analysis, they will be preserved as specified in Table 3-6 and maintained at the required temperature until packaged for shipment to the laboratories. FWS SOP-03 *Sample Packaging and Shipping* describes these procedures. Every effort will be made to deliver the samples to the analytical laboratories in a timely manner to meet the sample holding times.

To prepare samples for shipment,

- Secure the samples with bubble wrap. The cooler should have bubble wrap placed on the bottom of the cooler and the samples should be wrapped in bubble wrap if breakable or crushable containers are used.
- Add gel ice or cubitainers of frozen water to achieve the proper temperature and to ensure that the samples stay at a constant temperature for their entire trip.
- Pack samples tightly so that they cannot move freely in the cooler; they must be secure.
- An upper weight limit of 70 pounds per cooler is suggested.
- Place a temperature blank container in each cooler.
- Record the contents of the coolers and list them on the chain-of-custody (CoC) forms.
- Secure each cooler with two CoC seals.

Because storage and processing of samples for benthic ecology analyses involves the use of hazardous chemicals, proper packaging is required at all stages of collection, shipping, and processing. Packing and labeling will conform to IATA regulations for the sample preservative.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 119 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Samples will be stored in plastic jars with the threads wrapped in Teflon tape (or equivalent) to prevent leakage. Samples will be preserved in 10% formalin buffered with hexamine (or equivalent). Jars will be placed into coolers or a suitable storage container and covered with vermiculite to absorb any excess or spilled formalin. In general, formalin-preserved samples should be held at room temperature or slightly cooler and should be prevented from freezing, both pre- and post-analysis. In addition to external labeling, faunal samples should contain a matching internal label on waterproof paper.

3.5.2.3 Holding Times

Sample holding conditions and holding times are defined in Table 3-6. Holding times are calculated from the time of sample collection. Documentation must be sufficient to track sample holding, processing, and analysis times to ensure that holding times are met. Samples must be held in a controlled area with limited access.

Because sample shipment times are governed by helicopter schedules, it may not always be possible to ship samples to meet the standard 14 day to extraction period for PAH, SHC, TPH, and biomarker samples. Fabiana et al, 2010 showed that most PAH are stable for up to 41 days with a few high molecular weight PAH (dibenzo(a,h)anthracene, benzo(g,h,i)perylene) and benzo(b)fluoranthene) are stable for 22-30 days. These PAHs are insoluble and should not be present in the Chukchi Sea samples. However, spiked samples will be prepared and stored as samples (Section 3.7.1.6) to track sample integrity during extended storage periods.

Field samples collected for organics or metals analysis will be held for six months after delivery of final data; sample extracts and digestates will be held for one month. Disposal records for unextracted samples, extracted samples, sample containers, and sample extracts must be sufficient to provide tracking from collection, through laboratory receipt, to sample disposal.

3.5.2.4 Chain-of-Custody Records

Sample custody records are the administrative records associated with the physical possession and/or storage history of each individual sample from sample collection to the final analytical result and sample disposal. FWS SOP-02 *Sample Custody* and FWS SOP-03 *Sample Packaging and Shipping* describe these procedures. Sample custody will be initiated by the sample collection records that identify for each unique sample identification number the date, time, collection location, and collector.

During the survey, samples will be in the custody of the Field Leader, who will store samples securely under the preservation requirements defined in Table 3-6. When samples are packaged for shipment to the analytical laboratories, the Field Leader will verify that each sample is recorded on the appropriate custody form. Each sample custody form will be signed by the Field Leader, relinquishing the samples once he/she has verified that the custody form is accurate; *i.e.*, that all samples present in the shipping container are listed on the form, and that the sample descriptions, requested analytical methods, and sampling dates are accurate. The sample custody form provides a record of the samples collected and analyses requested. The custody form should be sealed in a plastic bag and taped to the inside lid of the cooler. The original sample custody forms accompany the samples; the shipper will keep a copy.

If more than one cooler is sent in one shipment to the laboratory, then each cooler will contain a separate custody record for the samples in that cooler. In addition, the outside of the coolers will be marked to indicate the number of coolers in the shipment (*e.g.*, 1 of 2, 2 of 2).

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 120 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Upon receipt at the designated laboratory, sample custody forms will be signed by the person receiving the samples once that person has verified that all samples identified on the custody forms are present in the shipping container. Any discrepancies will be noted on the form (in addition to any internal laboratory documentation policy) and the sample receiver will immediately contact the Project Manager to report missing, broken, or compromised samples.

Each analytical laboratory must have a formal, documented system designed to provide sufficient information to reconstruct the history of each sample, including preparation of sampling containers; sample collection and shipment; receipt, distribution, analysis, storage or disposal; and data reporting within the laboratory. Laboratory documentation must provide a record of custody for each sample throughout processing, analysis, and disposal.

Field custody of electronic data, including all data on navigation, CTD, dissolved oxygen, ADCP acoustic backscatter, and optical-backscatter turbidity will be the responsibility of the field survey's Chief Scientist. The field custody of the electronic data consists of creating DVD and/or thumb-drive backups of all electronic data generated each day. The label on the backup media will include a survey ID, date, and name of person creating the backup files. The data will be transferred to a system capable of physical oceanographic processing upon completion of the survey.

3.5.2.5 Sample Archiving

Samples must be archived under the conditions specified in Table 3-6 until the final analytical data have been received, reviewed, and approved by the project manager.

3.5.3 Field Instrument/Equipment Calibration, Maintenance, and Operation

Field equipment must be tested, maintained, and calibrated according to SOPs and the manufacturers' instructions prior to use in the field to avoid breakdowns that could impact schedule or loss of data. The instruction manuals and SOPs must be available for all field equipment so that trouble-shooting and routine repairs can be conducted in the field. Spare parts recommended by the manufacturer should be stocked on the vessel. Major maintenance should be documented in the field logbook. Maintenance must be documented to track instrument performance or problems. Documentation should include the name of the person performing the maintenance, date maintenance was performed, a description of the maintenance activity, and (if the maintenance was performed in response to a specific instrument performance problem) the result of re-testing to demonstrate that the instrument performance had been returned to acceptable standards prior to re-use. Calibration, maintenance, testing, and inspection requirements for field equipment are defined in Table 3-8.

3.6 Laboratory Analysis

3.6.1 Analytical Methods

A wide variety of analytical methods will be used to achieve environmentally realistic detection limits for this project. Table 3-9 summarized the methods by matrix and parameter class. As noted on the table, more than one method may be used for trace metals. Details are provided in laboratory SOPs provided in Appendix B to this QAPP.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 121 of 174
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Table 3-8 Field Equipment Calibration, Maintenance, Testing, and Inspection

Equipment	Activity	Frequency
Sea Bird SBE19plus CTD and sensors (or equivalent) ¹	Calibration	Prior to survey
	Maintenance	Prior to survey; as necessary
	Testing	After each cast
	Inspection	Visual inspection before and after each cast, data reviewed after each cast
GPS ²	Calibration	NA
	Maintenance	As necessary (dGPS systems do not require scheduled maintenance)
	Testing	As necessary (GPS systems do not require scheduled testing)
	Inspection	As per Ship's standard procedures, data accuracy will be continuous during critical navigation operations
Sediment Profile Imagery System ³	Calibration	Prior to survey
	Maintenance	Prior to survey; as necessary during survey (no scheduled maintenance)
	Testing	After each cast
	Inspection	Visual inspection before and after each cast; photographs reviewed after each cast

Notes:

¹ Samples/direct measurements collected: Conductivity/salinity, temperature, depth, , fluorescence, turbidity, transmissivity.

² Samples/direct measurements collected: Location of sampling equipment at time of sample or direct measurement.

³ Samples/direct measurements collected: sediment profile images, sediment characterization.

Table 3-9 Laboratory Analytical Methods

Compound Class (Units)	Method (EPA Citation)	Laboratory SOP Analysis Method
Water		
VOCs	EPA 8260 ¹	5-245 GC/MS purge and trap
PAH	EPA 8270	5-157 GC/MS
SHC/TPH	EPA 8015 (Mod)	5-202 GC/FID
Metals (Dissolved): Ba, , Cd, Ni, Pb, , Se, Sn, Tl	EPA 6010	FIT-0004 Series ICP-MS ²
Metals (Dissolved): Cr, Cu, , , Zn	EPA 7000	FIT-0004 Series FAAS ³
Metal (Dissolved):, As	EPA 7000	FIT-0004 Series ZGFAAS
Mercury (Dissolved)	EPA 1631e	FIT-0006 Series CVAF
Methylmercury (Dissolved)	EPA 1630	MSL-I-014 CVAF
Metals (Particulates): Ba	EPA 6010	6005 ICP-MS ⁴
Metals (Particulates): Al, Cr, Fe, Sb, Zn	EPA 7000	6003 FAAS
POC (Particulates)	Modified EPA 415.1	2014 TOC Analyzer
TSS (Particulates)	ASTM 3977-07, Method B	FIT-TSS Analytical Balance
Sediment and Drilling Mud/Cuttings		
VOCs, muds and cuttings only	EPA 8260	5-245 GC/MS purge and trap
PAH	EPA 8270	5-157 GC/MS
Petroleum Biomarkers	EPA 8270 (Mod)	5-157 GC/MS
SHC/TPH	EPA 8015 (Mod)	5-202 GC/FID
Metal: Ba, Be, Cd, Ni, Pb, Sb, Se, Sn, Tl	EPA 6010	FIT-2012 ICP-MS
Metals: Al, Cr, Cu, Fe, Ti, Zn	EPA 7000	FIT-2010 series FAAS
Metal: Ag, As	EPA 7000	FIT-2012 series ICP-MS
Total Mercury	EPA 7473	FIT-2014 CVAAS

**AKG-28-8100– Noble Discoverer
Revision 0, Effective Date May 2013**

Page 123 of 174

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Compound Class (Units)	Method (EPA Citation)	Laboratory SOP Analysis Method
Methylmercury	EPA 1630M	MSL-I-015 CVAF
TOC	Modified EPA 415.1	FIT-2015 TOC Analyzer
Grain Size	NA	Grain Size by sieve and pipette (Folk, 1974)
Tissue		
PAH/Petroleum	EPA 8270	5-157 GC/MS
Petroleum Biomarkers	EPA 8270 (Mod)	5-157 GC/MS
SHC/TPH	EPA 8015 (Mod)	5-202 GC/FID
Metal: Ba, Be, Cd, Ni, Pb, Sb, Se, Sn, Tl	EPA 6010	FIT-1000 series ICP-MS
Metals: Al, Cr, Cu, Fe, Ti, Zn	EPA 7000	FIT-1013 series FAAS
Metal: Ag, As	EPA 7000	FIT-1012 Series ICP-MS
Total Mercury	EPA 7473	FIT-1014 CVAAS
Methylmercury	EPA 1630M	MSL-I-015 CVAF
Percent Lipid	NA	SOP 5-190 Gravimetric

Notes:

¹ VOC compounds are the Method 602 compounds plus o, m, p-xylene.

² Inductively-coupled plasma-mass spectrometer (ICP-MS) following preconcentration using method of Nakashima et al. (1988).

³ USEPA SW-846 Method 7000 Series with analysis by Flame Atomic Absorption Spectrophotometer (FAAS) according to FIT 6003 Digestion according to Trefry and Trocine (1991).

⁴ USEPA SW-846 Method Series 6020B with analysis by inductively coupled plasma/mass spectrometry (ICP-MS) according to FIT SOP 6005. Digestion according to Trefry and Trocine (1991).

3.6.2 Samples for Metals Analysis

Samples of drill cuttings, mud samples, water, sediments, and tissues will be analyzed for a suite of metals. The analyses will be conducted following protocols that have been developed specifically for reliable trace-level analysis of the target metals in complex marine environmental samples. The analytical protocols have been used extensively for baseline characterization and monitoring the potential impact of off-shore oil and gas activities in Alaska, including in the CSESP, Chukchi Offshore Monitoring In Drilling Area – Chemistry and Benthos (COMIDA-CAB), Arctic Nearshore Impact Monitoring In Development Area (ANIMIDA), and Continuation of Arctic Nearshore Impact Monitoring In Development Area (cANIMIDA) programs. Table 3-10 lists the metals that will be analyzed for each phase of the EMP and the applicable analytical instrument.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 124 of 174
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3.6.2.1 Metals in Water (Phase II) Samples

Dissolved water samples collected during drilling activities (Phase II) will be analyzed for a suite of 13 metals (Table 3-10), based on a revised list streamlined to reflect each specific metal's aqueous solubility and relevance in drilling muds and cuttings. The dissolved-phase water samples will be pre-concentrated prior to analysis. Particulate water samples collected during the plume-monitoring component in Phase II will be analyzed for 6 metals (Table 3-10) known to be indicators of particles derived from drilling muds and cuttings; the suspended particles will be air-dried (at 50% humidity). The samples will be analyzed by flame atomic absorption spectrometry (FAAS), graphite furnace atomic absorption spectrometry (GFAAS; with Zeeman or Continuum background correction [ZGFAAS]), cold vapor atomic absorption spectrometry (CVAAS), or inductively coupled plasma/mass spectrometry (ICP/MS) for determination of the different metals. Mercury concentrations will be measured by Cold Vapor Atomic Fluorescence (CVAF). These methods are based on USEPA methods described for Series 7000 (FAAS and GFAAS), Series 1630 and 1631e (CVAF), and Series 6010A (ICP/MS), with optimization to address the required detection limits and the sample matrices.

3.6.2.2 Metals in Sediment (Phases II, III, and IV) Samples

Sediment samples and neat muds and cuttings samples will be analyzed for a suite of 19 metals (see Table 3-10). The well-mixed mud/cuttings and sediment will be freeze-dried and then totally digested in Teflon[®] beakers using concentrated high-purity hydrofluoric acid (HF), nitric acid (HNO₃) and perchloric acid (HClO₄). The liquid-phase and clear samples will be diluted with distilled deionized water (DDW) prior to analysis. The dissolved-phase water samples will be concentrated prior to analysis. Sediment samples to be analyzed for mercury will be digested by heating with HNO₃ and sulfuric acid (H₂SO₄). The samples will be analyzed by FAAS, CVAF, cold vapor atomic absorption spectrometry (CVAAS), or ICP/MS for determination of the different metals. Total mercury concentrations will be measured by CVAAS and methylmercury by CVAF. These methods are based on USEPA methods described for Series 7000 (FAAS and ICP-MS), Series 7473 (CVAAS), Series 1630M (CVAF), and Series 6010A (ICP/MS, with optimization to address the required detection limits and the sample matrices). Analyses of muds and cuttings for concentrations of total recoverable metals will be conducted following methods specified in 40CFR Part 136, and results will be reported in mg/kg of whole mud (dry weight) and moisture content (percent by weight) of the original drilling-fluid sample. Laboratory limits of quantitation (LOQ) and limits of detection (LOD) are defined in Table 3-10).

Analyses of muds and cuttings for concentrations of total recoverable metals will be conducted following methods specified in 40CFR Part 136, and results will be reported in mg/kg of whole mud (dry weight) and moisture content (percent by weight) of the original drilling-fluid sample.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 125 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 126 of 174
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Table 3-10 Metals and Analytical Instruments for Each Phase of Environmental Monitoring with Laboratory Limits

Analyte	Analytical Instrument ¹	Dissolved Water		Particulate Water		Sediment & Drilling Mud/Cuttings		Tissue	
		LOQ (µg/L)	LOD (µg/L) ²	LOQ	LOD	LOQ (ng/g)	LOD (ng/g)	LOQ (µg/g)	LOD (µg/g)
Aluminum (Al)	FAAS	3	-	0.15 %	0.3 %	0.05%	0.01%	TBD ⁴	TBD
Antimony (Sb)	FAAS (Particulates) ICP-MS (other)	-	-	0.2 µg/g	0.04 µg/g	0.005	0.001	TBD	TBD
Arsenic (As)	ICP-MS	0.1	0.020	-	-	0.10	0.02	0.06	0.012
Barium (Ba)	ICP-MS	0.38	0.075	9 ng/g	1.8 ng/g	0.05	0.01	0.03	0.006
Beryllium (Be)	ICP-MS	-	-	-	-	0.045	0.009	TBD	TBD
Cadmium (Cd)	ICP-MS	0.0075	0.0015	-	-	0.005	0.001	0.005	0.001
Chromium Cr	FAAS	0.075	0.015	1.5 ng/g	0.3 ng/g	8 µg/g	1.6 µg/g	0.015	0.003
Copper (Cu)	FAAS	0.05	0.010	-	-	8.5 µg/g	1.7 µg/g	0.01	0.002
Iron (Fe)	FAAS	-	-	0.15 %	0.03 %	0.05%	0.01%	12.5	2.5
Mercury (Hg), Total	CVAF (Dissolved) CVAAS (other)	0.2 ng/L	0.05ng/L	-	-	5	12	5 ng/g	1.9 ng/g
Methylmercury (MeHg)	CVAF	0.05 ng/L	0.02 ng/L	-	-	0.05	0.01	5 ng/g	1.5 ng/g
Nickel (Ni)	ICP-MS	0.05	0.010	-	-	0.020	0.004	0.02	0.004
Lead (Pb)	ICP-MS	0.01	0.0020	-	-	0.010	0.002	0.005	0.001
Selenium (Se)	ICP-MS	0.075	0.015	-	-	0.12	0.024	0.075	0.015
Silver (Ag)	ICP-MS	-	-	-	-	0.015	0.003	0.005	0.001
Tin (Sn)	ICP-MS	TBD	TBD	-	-	0.015	0.003	0.01	0.002
Titanium (Ti)	FAAS	-	-	-	-	0.1%	0.02%	0.1%	0.02%
Thallium (Tl)	ICP-MS	0.5 ng/L	0.1 ng/L	-	-	0.005	0.001	TDB	TDB
Zinc (Zn)	FAAS	0.075	0.015	3.5 µg/g	0.78 µg/g	2.5 µg/g	0.5 µg/g	2	0.4

Notes:

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 127 of 174
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*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

¹ CVAAS = Cold Vapor Atomic Absorption Spectrometry; FAAS = Flame Atomic Absorption Spectrometry; GFAAS = Graphite Furnace Atomic Absorption Spectrometry; ICP/MS = Inductively Coupled Plasma/Mass Spectrometry; and ZGFAAS = Zeeman Graphite Furnace Atomic Absorption Spectrometry.

² Laboratory detection limits are verified and updated periodically according to the organization's quality system. Detection limits current at the time of analysis may vary from those defined in this QAPP. The actual laboratory LOQs and LODs will be reported with the laboratory data.

³ Not a compound of interest for this matrix.

⁴ To be determined (TBD). Laboratory LODs will be developed and reported with the study data.

<p style="text-align: center;">AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013</p>	<p style="text-align: center;">Page 128 of 174</p>
<p>CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.</p>	

3.6.2.3 Metals in Tissue (Phases III and IV) Samples

Tissue samples will be analyzed for a suite of 19 metals (Table 3-10). Tissue samples for all metals, with the exception of Hg, will be freeze-dried and then digested by sequential addition of concentrated, high-purity nitric acid (HNO₃), hydrogen peroxide (H₂O₂), and hydrochloric acid (HCl). The solution will be diluted with distilled/deionized (DDW). Mercury analyses will be conducted following digestion with concentrated, high-purity HNO₃ and H₂SO₄.

The samples will be analyzed by FAAS, CVAf, CVAAS, or ICP/MS for determination of the different metals. Mercury concentrations will be measured by CVAf and CVAAS. These methods are based on USEPA methods described for Series 7000 (FAAS), Series 1630M (CVAf), Series 7473 (CVAAS), and Series 6010A (ICP/MS, with optimization to address the required detection limits and the sample matrices).

3.6.3 Samples for Hydrocarbon Analysis (Phases II, III, and IV)

Samples of drilling mud, cuttings, sediment, and tissues will be analyzed for a suite of PAH, petroleum biomarkers (sterane/triterpanes; St/Tr), TPH, and SHC compounds. Water samples collected during Phase II monitoring will be analyzed for VOCs, TPAH, SHC and TPH, but petroleum biomarkers will not be measured in the water samples. The analyses will be conducted following SOPs (e.g., 5-157, see Table 3-9) that have been developed specifically for reliable trace-level analysis of the target parameters in complex marine environmental samples. The analytical protocols have been used extensively for baseline characterization and monitoring the potential impact of offshore oil and gas activities in Alaska, including in the CSESP, ANIMIDA, and cANIMIDA programs for hydrocarbon analysis and the COMIDA program for metals analysis.

The instrumental analysis will be conducted following methods that are modified from US EPA Methods 8015 (SHC) and 8270 (PAH and biomarkers), to obtain improved sensitivity and specificity, to include a number of additional key target parameters (e.g., alkyl PAHs and petroleum biomarkers), and to ensure that the analysis is appropriate for complex samples of drilling mud/cuttings, sediments, and biological tissues. The sample analyses are summarized below.

3.6.3.1 Hydrocarbons in Water Samples (Phase II)

Water samples will be extracted for VOCs, PAH, SHC, and TPH compounds (Table 3-11 and Table 3-12) following laboratory SOPs. Briefly, water samples will be prepared by fortifying a 1–2 L sample with surrogate internal standard (SIS) compounds, serially extracting the analytes of interest with dichloromethane (DCM), and preparing the samples for instrumental analysis. The sample extract will be dried and concentrated over anhydrous sodium sulfate, then will be purified with an alumina clean-up column. The extract will be concentrated and spiked with internal standards (IS) and split for instrumental analysis. One split will be submitted for SHC and TPH analysis by modified EPA Method 8015 by using gas chromatography with flame-ionization detection (GC/FID). The other split will be submitted for PAH analysis that uses a modified EPA Method 8270 gas chromatography/mass spectrometry (GC/MS) method with the detector operating in the selected ion-monitoring (SIM) mode. Target compounds will be

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 129 of 174
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quantified by using the method of internal standards using the SIS compounds resulting in surrogate recovery-corrected data generated to represent the native sample concentrations. Laboratory reporting limits (RL) and method detection limits (MDLs) are reported in Table 3-11 and Table 3-12.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 130 of 174
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Table 3-11 List of Polycyclic Aromatic Hydrocarbon and Alkyl PAH Target Analytes with Reporting Limits and Method Detection Limits

Parameter	Whole Water (ng/L)		Sediment (ng/g dry)		Tissues (ng/g wet)	
	RL	MDL ¹	RL	MDL	RL	MDL
Naphthalene²	2.5	1.682	1.0	0.18	0.5	0.39
C1-Naphthalenes	2.5	1.682	1.0	0.18	0.5	0.39
C2-Naphthalenes	2.5	1.682	1.0	0.18	0.5	0.39
C3-Naphthalenes	2.5	1.682	1.0	0.18	0.5	0.39
C4-Naphthalenes	2.5	1.682	1.0	0.18	0.5	0.39
Biphenyl	2.5	0.732	1.0	0.198	0.5	0.242
Acenaphthylene	2.5	0.543	1.0	0.177	0.5	0.365
Acenaphthene	2.5	0.75	1.0	0.243	0.5	0.283
Dibenzofuran	2.5	0.744	1.0	0.198	0.5	0.283
Fluorene	2.5	0.935	1.0	0.171	0.5	0.361
C1-Fluorenes	2.5	0.935	1.0	0.171	0.5	0.361
C2-Fluorenes	2.5	0.935	1.0	0.171	0.5	0.361
C3-Fluorenes	2.5	0.935	1.0	0.171	0.5	0.361
Anthracene	2.5	0.854	1.0	0.177	0.5	0.327
Phenanthrene	2.5	0.83	1.0	0.147	0.5	0.343
C1-Phenanthrenes/Anthracenes	2.5	0.83	1.0	0.147	0.5	0.343
C2-Phenanthrenes/Anthracenes	2.5	0.83	1.0	0.147	0.5	0.343
C3-Phenanthrenes/Anthracenes	2.5	0.83	1.0	0.147	0.5	0.343
C4-Phenanthrenes/Anthracenes	2.5	0.83	1.0	0.147	0.5	0.343
Retene	2.5	1.68	1.0	0.078	0.5	TBD ³
Dibenzothiophene	2.5	0.902	1.0	0.168	0.5	0.317
C1-Dibenzothiophene	2.5	0.902	1.0	0.168	0.5	0.317
C2-Dibenzothiophene	2.5	0.902	1.0	0.168	0.5	0.317

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 131 of 174
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*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

Parameter	Whole Water (ng/L)		Sediment (ng/g dry)		Tissues (ng/g wet)	
	RL	MDL ¹	RL	MDL	RL	MDL
C3-Dibenzothiophene	2.5	0.902	1.0	0.168	0.5	0.317
C4-Dibenzothiophene	2.5	0.902	1.0	0.168	0.5	0.317
Fluoranthene	2.5	0.935	1.0	0.141	0.5	0.302
Pyrene	2.5	0.755	1.0	0.393	0.5	0.264
C1-Fluoranthenes/Pyrenes	2.5	0.755	1.0	0.393	0.5	0.264
C2-Fluoranthenes/Pyrenes	2.5	0.755	1.0	0.393	0.5	0.264
C3-Fluoranthenes/Pyrenes	2.5	0.755	1.0	0.393	0.5	0.264
C4-Fluoranthenes/Pyrenes	2.5	0.755	1.0	0.393	0.5	0.264
Benzo(a)anthracene	2.5	1.325	1.0	0.216	0.5	0.28
Chrysene	2.5	0.693	1.0	0.111	0.5	0.28
C1-Chrysenes	2.5	0.693	1.0	0.111	0.5	0.28
C2-Chrysenes	2.5	0.693	1.0	0.111	0.5	0.28
C3-Chrysenes	2.5	0.693	1.0	0.111	0.5	0.28
C4-Chrysenes	2.5	0.693	1.0	0.111	0.5	0.28
Benzo(b)fluoranthene	2.5	0.902	1.0	0.228	0.5	0.236
Benzo(k)fluoranthene	2.5	1.673	1.0	0.237	0.5	0.189
Benzo(e)pyrene	2.5	0.812	1.0	0.192	0.5	0.214
Benzo(a)pyrene	2.5	1.169	1.0	0.3	0.5	0.308
Perylene	2.5	1.175	1.0	0.219	0.5	0.519
Indeno(1,2,3-cd)pyrene	2.5	1.607	1.0	0.351	0.5	0.17
Dibenz(a,h)anthracene	2.5	1.361	1.0	0.321	0.5	0.233
Benzo(g,h,i)perylene	2.5	1.748	1.0	0.489	0.5	0.484

Notes:

¹ Laboratory MDLs are verified and updated periodically according to the organization's quality system. MDLs current at the time of analysis may vary from those defined in this QAPP. The actual laboratory MDLs and RLs will be reported with the laboratory data.

² Bolded compounds are the 16 priority PAH pollutants.

³ To be determined (TBD). Laboratory MDLs will be developed and reported with the study data.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 132 of 174
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Table 3-12 List of Saturated Hydrocarbons Target Analytes with Reporting Limits and Method Detection Limits

Parameter	Whole Water (ng/L)		Sediment and Drilling Mud/Cuttings (ng/g dry)		Tissues (ng/g wet)	
	RL	MDL ¹	RL	MDL	RL	MDL
n-Nonane	250	90	50	3	0.1	TBD ²
n-Decane	250	99	50	24	0.1	TBD
n-Undecane	250	66	50	6	0.1	TBD
n-Dodecane	250	69	50	6	0.1	TBD
n-Tridecane	250	72	50	6	0.1	TBD
Isoprenoid RRT 1380	NA ³	NA	NA	NA	0.1	TBD
n-Tetradecane	250	78	50	6	0.1	TBD
Isoprenoid RRT 1470	NA	NA	NA	NA	0.1	TBD
n-Pentadecane	250	99	50	6	0.1	TBD
n-Hexadecane	250	93	50	6	0.1	TBD
Norpristane (1650)	NA	NA	NA	NA	0.1	TBD
n-Heptadecane	250	78	50	3	0.1	TBD
Pristane	250	72	50	3	0.1	TBD
n-Octadecane	250	69	50	6	0.1	TBD
Phytane	250	66	50	6	0.1	TBD
n-Nonadecane	250	63	50	6	0.1	TBD
n-Eicosane	250	60	50	6	0.1	TBD
n-Heneicosane	250	60	50	6	0.1	TBD
n-Docosane	250	54	50	6	0.1	TBD
n-Tricosane	250	57	50	6	0.1	TBD
n-Tetracosane	250	57	50	6	0.1	TBD
n-Pentacosane	250	63	50	6	0.1	TBD
n-Hexacosane	250	60	50	6	0.1	TBD

AKG-28-8100– Noble Discoverer
Revision 0, Effective Date May 2013

Page 133 of 174

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*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

Parameter	Whole Water (ng/L)		Sediment and Drilling Mud/Cuttings (ng/g dry)		Tissues (ng/g wet)	
	RL	MDL ¹	RL	MDL	RL	MDL
n-Heptacosane	250	60	50	3	0.1	TBD
n-Octacosane	250	63	50	6	0.1	TBD
n-Nonacosane	250	60	50	6	0.1	TBD
n-Triacontane	250	60	50	6	0.1	TBD
n-Hentriacontane	250	57	50	6	0.1	TBD
n-Dotriacontane	250	60	50	6	0.1	TBD
n-Tritriacontane	250	57	50	6	0.1	TBD
n-Tettriacontane	250	57	50	6	0.1	TBD
n-Pentatriacontane	250	54	50	6	0.1	TBD
n-Hexatriacontane	250	57	50	6	0.1	TBD
n-Heptatriacontane	250	60	50	6	0.1	TBD
n-Octatriacontane	250	48	50	6	0.1	TBD
n-Nonatriacontane	250	51	50	9	0.1	TBD
n-Tetracontane	250	69	50	9	0.1	TBD
SHC Total (C9-C40)	NA	NA	NA	NA	NA	NA
TPH Total (C9-C40)	NA	NA	NA	NA	NA	NA

Notes:

¹ Laboratory MDLs are verified and updated periodically according to the organization's quality system. MDLs current at the time of analysis may vary from those defined in this QAPP. The actual laboratory MDLs and RLs will be reported with the laboratory data.

² To be determined (TBD). Laboratory MDLs will be developed and reported with the study data.

³ Standards are not available for this compound. The RL and MDL of the compound which elutes prior to the isoprenoid compound is applied.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 134 of 174
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Water samples will be analyzed for VOCs using gas chromatography by purge-and-trap techniques (Table 3-13). Samples are spiked with SIS and RIS and an inert gas is bubbled through the water samples. The VOCs are purged from the aqueous phase to the gas phase, which is swept through a sorbent trap where the VOCs are trapped, heated and back flushed with inert gas to desorb the components onto a non-polar fused silica capillary chromatographic column, separated via capillary gas chromatography, and identified and quantified using electron ionization mass spectrometry in the Full Scan mode. Target compounds will be quantified by using the method of internal standards using the SIS compounds resulting in surrogate recovery-corrected data generated to represent the native sample concentrations.

Table 3-13 List of Volatile Organic Carbon Target Analytes with Reporting Limits and Method Detection Limits

Parameter	Whole Water (µg/L)		Drilling Muds and Cuttings (ng/g)	
	RL	MDL ¹	RL	MDL
1,2-Dichlorobenzene ²	0.0025	0.000684	1.00	0.195
1,3-Dichlorobenzene ²	0.0025	0.000684	1.00	0.195
1,4-Dichlorobenzene ²	0.0025	0.000684	1.00	0.195
Benzene	3.04	0.23	12.17	4.38
Chlorobenzene ²	TBD ^{2,3}	TBD	TBD	TBD
Ethylbenzene	2.75	0.15	10.98	3.63
Toluene	1.99	0.14	7.97	2.72
m-xylene	0.898	0.106	3.593	1.436
p-xylene	1.932	0.204	7.730	2.674
o-xylene	0.915	0.063	3.660	1.298

Notes:

¹ Laboratory MDLs are verified and updated periodically according to the organization's quality system. MDLs current at the time of analysis may vary from those defined in this QAPP. The actual laboratory MDLs and RLs will be reported with the laboratory data.

² These parameters may be analyzed by GC/MS purge and trap (SOP 5-245) or GC/MS SIM (SOP 5-157). MDLs are for GC/MS SIM.

³ To be determined (TBD). Laboratory MDLs will be developed and reported with the study data.

3.6.3.2 Hydrocarbons in Sediment Samples (Phases III and IV)

Samples of sediments, drilling muds, and cuttings will be extracted for PAH (Table 3-11), SHC and TPH (Table 3-12), and petroleum biomarkers St/Tr (Table 3-14), following laboratory SOPs. Muds and cuttings will also be analyzed for VOCs. Briefly, approximately 30 g of wet sediment will be fortified with SIS compounds and serially extracted with DCM. Less material may be used for the analyses of used drilling mud and cuttings because they may contain higher hydrocarbon concentrations than native sediment.

The sample extract will be dried and concentrated over anhydrous sodium sulfate. The extract will be purified with activated copper to remove any sulfur that is present and then will be purified further with an alumina clean-up column; a subsample will be removed for TPH analysis. The remaining extract then will be purified further using silica gel column fraction to isolate the SHC fraction and petroleum biomarker fraction (F1) from the aromatic hydrocarbon fraction (F2). The resulting extracts will be concentrated and spiked with IS compounds. The TPH and F1 extracts will be submitted for TPH and SHC analysis by modified EPA Method 8015 and GC/FID and for petroleum biomarkers analysis by

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 135 of 174
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modified EPA Method 8270 using GC/MS-SIM. The F2 extract will be submitted for PAH analysis also using the modified EPA Method 8270 by GC/MS-SIM analysis. Target compounds will be quantified by using the method of internal standards using the SIS compounds resulting in surrogate recovery-corrected data generated to represent the native sample concentrations. The laboratory also will determine the sediment grain size and the total organic carbon (TOC) content of the sediments. Sediments will be processed by the sieve and pipette methods to determine sediment grain size with data for the following four fractions: gravel, sand, silt, and clay. For organic matter, the TOC content will be measured at 900°C with a total-carbon analyzer.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 136 of 174
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Table 3-14 List of Petroleum Biomarker (St/Tr) Target Analytes with Reporting Limits and Method Detection Limits

Compound	Synonym	Sediment (ng/g dry)		Tissue (ng/g wet)	
		RL	MDL ¹	RL	MDL
C ₂₃ Diterpane	T4-C23Diterpane	3.00	NA ²	1.5	NA ²
13β,17α-diacholestane(20S)	S4-Diacholestane	1.00	NA ³	0.5	NA ³
13β,17α-diacholestane(20R)	S5-Diacholestane	1.00	NA ³	0.5	NA ³
C ₂₉ Tricyclitriterpane	T9-C29Tricyclitriterpane	3.00	NA ²	1.5	NA ²
C ₂₉ Tricyclitriterpane	T10-C29Tricyclitriterpane	3.00	NA ²	1.5	NA ²
5α,14α,17α-cholestane(20R)	Cholestane	1.00	0.084	0.5	TBD ⁴
18α(H)-22,29,30-trisnorhopane(TS)	T11-Trisnorhopane(TS)	3.00	NA ²	1.5	NA ²
17α(H)-22,29,30-trisnorhopane(TM)	T12-Trisnorhopane(TM)	3.00	NA ²	1.5	NA ²
5α,14α,17α,24-methylcholestane(20R)	S24-Methylcholestane	1.00	NA ³	0.5	NA ³
5α,14α,17α,24-ethylcholestane(20S)	S27-Ethylcholestane(25S)	1.00	NA ³	0.5	NA ³
5α,14α,17α,24-ethylcholestane(20R)	S28-Ethylcholestane	1.00	NA ³	0.5	NA ³
17α(H),21β(H)-30-norhopane	T15-Norhopane	3.00	NA ²	1.5	NA ²
18α(H)-oleanane	T18-Oleanane	3.00	NA ²	1.5	NA ²
17α(H),21β(H)-hopane	T19-Hopane	3.00	NA ²	1.5	NA ²
22S-17α(H),21β(H)-30-homohopane	T21-Homohopane	3.00	NA ²	1.5	NA ²
22R-17α(H),21β(H)-30-homohopane	T22-Homohopane	3.00	NA ²	1.5	NA ²
17β(H),21β(H)-hopane	17β(H),21β(H)-hopane	3.00	0.318	1.5	TBD ⁴

Notes:

¹ Laboratory MDLs are verified and updated periodically according to the organization's quality system. MDLs current at the time of analysis may vary from those defined in this QAPP. The actual laboratory MDLs and RLs will be reported with the laboratory data.

² Not available (NA). Standards are not available for this compound. The RL and MDL for 17β(H),21β(H)-hopane will be applied to the data.

³ Not available (NA). Standards are not available for this compound. The RL and MDL for Cholestane will be applied to the data.

⁴ To be determined (TBD). Laboratory MDLs will be developed and reported with the study data.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 137 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 138 of 174
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3.6.3.3 Hydrocarbons in Tissue Samples (Phases III and IV)

Samples of biological tissues will be extracted for PAH (Table 3-11), SHC and TPH (Table 3-12), and petroleum biomarkers St/Tr (Table 3-14) following laboratory SOPs. Briefly, about 20 g of wet tissue will be fortified with SIS compounds and serially extracted with DCM. The tissue will be extracted by maceration using a TissueMizer® or equivalent, with stainless-steel probes. The sample extract will be dried and concentrated over anhydrous sodium sulfate. The extract will be purified with activated copper to remove any sulfur that is present and then will be purified further with an alumina clean-up column; a subsample then will be removed for TPH analysis. The remaining extract then will be purified further with silica-gel column fraction to isolate the saturated hydrocarbon fraction and petroleum biomarker fraction (F1) from the aromatic hydrocarbon fraction (F2). The resulting extracts will be concentrated and spiked with IS compounds. The TPH and F1 extracts will be submitted for TPH and SHC analyses by modified EPA Method 8015 and GC/FID and for analysis of petroleum biomarkers by modified EPA Method 8270 using GC/MS-SIM. The F2 extract will be submitted for PAH analysis using the modified EPA Method 8270 by GC/MS-SIM analysis. Target compounds will be quantified by using the method of internal standards using the SIS compounds resulting in surrogate recovery-corrected data generated to represent the native sample concentrations. The laboratory also will determine the lipid content of the tissue, based on the total extractable material (TEM).

3.6.4 Macrofaunal Analysis

Sediment samples will be processed shipboard by sieving according to methods outlined in Section 3.5.1.8, and taxonomic analysis will be conducted on infaunal invertebrates to determine community composition. In the laboratory, receipt of benthic samples will be logged and processing steps recorded in a notebook to track each sample. Samples will be kept in formalin for a minimum of 1 month, and preferably no longer than 4 months, to prevent decalcification of small bivalve shells. After 1–3 months, the formalin in benthic samples will be decanted and the samples rinsed and then preserved in isopropyl alcohol (or ethanol). Decanted formalin and rinsing water will be poured through a 0.5-mm mesh screen or smaller to capture any specimens that otherwise would be lost. Biological tissues in the 1.0-mm-mesh sieve samples will be sorted from the sediment remains, and the invertebrate animals will be identified to the lowest practical taxonomic category. A small sample “tag” will be created on waterproof paper for each group of specimens of similar taxonomic determination to follow that group through identification and weighing. Samples will be weighed for wet-weight biomass and stored in alcohol in a plastic jar along with the specimen tags. Data will be entered into a computer with a database program. After analysis, samples should be moved to glass jars for long-term storage and archival. Lids should be sealed with electrical tape or parafilm to reduce the rate of evaporation of fluids.

Resulting metrics include taxonomic identification, abundance (individuals m⁻²), and biomass (g m⁻²). The data on benthic density and biomass resulting from taxonomic analysis will be used for statistical analysis consistent with methods applied elsewhere in investigations of benthic communities in Alaska. The community data will be analyzed following methods appropriate for ecological community data (e.g., repeated-measures ANOVA, geostatistical analysis for mapping changes, and multivariate analysis of the community-composition data to determine spatial and temporal trends in the faunal communities).

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 139 of 174
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Common multivariate analytical tools useful for ecological data include cluster analysis, canonical correspondence analysis (CCA), non-metric multidimensional scaling (nMDS), and principal components analysis (PCA). These methods have been widely applied to benthic community data for documenting ecological disturbance and recovery in benthic communities (Blanchard and Feder, 2003; Blanchard et al., 2010). A small subset of samples employed for community analysis should be reprocessed by a different technician or multiple technicians, when appropriate. Where questions arise, specimens should be compared with the authoritative voucher sets or sent to an appropriate taxonomic expert. Quality-control methods for benthic taxonomic analysis will follow guidelines outlined in SOP SAM043.01.

3.6.5 Sediment Profile Imagery Analysis

Table 3-15 below identifies the range of parameters that may be evaluated from the sediment photos. Further descriptions of the parameter groups are provided below.

Table 3-15 Sediment Profile Imagery Parameters

Parameter	Units	Method	Description
Sediment grain size	Modal ϕ interval	Visual analysis (V)	An estimate of sediment types present. Determined from comparison of images of known grain size.
Prism penetration	cm	Computer analysis (CA)	A geotechnical estimate of sediment compaction. Average of maximal and minimal distances from sediment surface to bottom of prism window.
Sediment surface relief	cm	CA	An estimate of small-scale bed roughness. Maximal depth of penetration minus minimal depth.
Apparent Redox Potential Discontinuity depth (from color change in sediment)	cm	CA	Estimate of depth to which sediments appear to be oxidized. Area of aerobic sediment divided by width of digitized image
Thickness of sediment layers	cm	CA	Measure thickness above original sediment surface
Methane/Nitrogen Gas Voids	number	V	Count
Epifaunal Occurrence	number	V	Count, identify
Tube Density	number/cm ²	V	Count
Tube Type			
Burrow Structures	—	V	Identify
Pelletal Layer	cm	V	Measure thickness, area
Bacterial Mats	—	V	Determine presence and color
Infaunal occurrence	number	V	Count, identify
Feeding Voids	number	V	Count, measure thickness, area
Apparent Successional Stage	—	V,CA	Estimated based on all of the above parameters
Organism Sediment Index	—	CA	Derived from RPD, successional stage, gas voids (Rhoads and Germano 1986)

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 140 of 174
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Sediment Grain Size—This parameter is a textural feature of the sediment used to describe the type of sediment present. Based on grain-size distribution, the nature of the physical forces acting on a habitat can be inferred. The sediment-type descriptors used follow the Wentworth classification as described in Folk (1974) and represent the major modal class for each layer identified in an image. Grain size is determined by comparison of collected images with a set of standard images for which mean grain size has been determined in the laboratory. Proportions of gravel, sand, silt, and clay sediment-grain-size fractions are estimated from the images.

Prism Penetration—This parameter provides an indication of sediment stiffness, with the profile camera prism acting as a penetrometer. The further the prism enters into the sediment, the softer the sediment is and typically indicates higher water content. Penetration is measured as the distance from the leading (deeper) edge of the prism to the sediment-water interface, up the length of the face plate. If the weight of the camera frame is not changed during image collection, the prism penetration provides a means for assessing the relative compaction between stations. In the unlikely event adjustments to weight and/or flotation are made, a minimum of three replicate drops with both system weight/flotation setups will be made to provide corrections for prism penetration calculations.

Surface Relief—Surface relief is measured as the difference between the maximal and minimal penetration measurements recorded from the sea bottom in one image. Another way to describe this measurement is the distance between the ‘peaks’ and ‘valleys’ of the sea bottom within the image. This parameter provides an estimate of small-scale bed roughness, on the order of the width of the prisms face plate (15 cm). The causes of roughness often can be determined from visual analysis of the images. In physically-dominated sandy habitats, surface relief typically consists of small sand waves or bed forms (the shape of the surface of a bed of sediment (i.e., the sea bottom), produced by the flow of water over the sediment). In muddy, cohesive sediments in low water velocity habitats, surface irregularity is primarily caused by activity of benthic organisms that form mounds or depressions during feeding and burrowing. In the absence of biological or physical influences, the surface can be smooth. Biologically caused surface roughness can range from small fecal mounds and tubes to large colonies of hydroids or submerged aquatic vegetation (SAV). Surface relief provides qualitative and quantitative data on habitat characteristics, which can be used to evaluate recent and existing habitat quality.

Apparent Color Redox Potential Discontinuity (SPI RPD) Layer—This parameter is an important estimator of benthic habitat quality. It is the depth to which sediments are oxidized. The term “apparent” is used in describing this parameter because no actual measurement is made of the redox potential. An assumption is made that, given the complexities of iron and sulfate reduction-oxidation chemistry, reddish-brown sediment color tones (Diaz and Schaffner 1988) are indications that the sediments are oxic or at least are not intensely reducing. This assumption is in accordance with the classical concept of RPD depth, which associates it with sediment color (Fenchel 1969). The depth of the apparent color RPD is defined as the area of all the pixels in the image discerned as being oxidized divided by the width of the digitized image. Using the area of the prism oxidized area divided by the width is the mechanism for determining the average apparent RPD color depth. The area of the image with oxic sediment is obtained by digitally manipulating the image to enhance characteristics associated with oxic sediment (greenish-

<p style="text-align: center;">AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013</p>	<p style="text-align: right;">Page 141 of 174</p>
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brown color tones). The enhanced area then is determined from a density slice of the image; if image quality is poor, the area is delineated with the cursor.

The apparent color RPD is useful in assessing the quality of a habitat for epifauna and infauna from both physical and biological points of view. Rhoads and Germano (1986) and Diaz and Schaffner (1988) found the depth of the RPD from profile images to be directly correlated to the quality of the benthic habitat in polyhaline and mesohaline estuarine zones. Thin RPDs, on the order of a few millimeters, tend to be associated with some environmental stress, whereas areas with deep RPDs, over 3 cm, were usually found to have flourishing epibenthic and infaunal communities. Data from locations near the discharge are compared to locations further away (reference locations) to assess changes in the apparent color RPD.

Surface Features—A variety of physical and biological features can be seen at or on the sediment surface. These features can range from SAV, worm tubes, fecal pellets, epibenthic organisms, bacterial mats, algal mats, shells, mud clasts, and bed forms to feeding pits and mounds. Each of these features provides information on the type of habitat and its quality. The presence of certain surface features is indicative of the overall nature of a habitat. For example, bed forms always are associated with physically dominated habitats, whereas the presence of worm tubes or feeding pits would be indicative of a more biologically dominated habitat (Rhoads and Germano 1982, 1986; Diaz and Schaffner, 1988). Surface features are evaluated visually from each slide and compiled by type and frequency of occurrence.

Subsurface Features—Subsurface features include a wide variety of features (such as infaunal organisms, burrows, water-filled voids, gas voids, or sediment layering) and reveal information about physical and biological processes influencing the sea floor. Subsurface features also provide data about the physical–biological control occurring in a habitat. For example, the presence of gas voids containing a mixture of nitrogen and methane from bacterial metabolism has been found to be an indication of anaerobic metabolism (Rhoads and Germano 1986) and is associated with high rates of bacterial activity. Muddy habitats with large amounts of methane gas generally are associated with areas of oxygen stress or high organic loading. On the other hand, habitats with burrows, infaunal feeding voids, and/or visible infauna are generally more biologically accommodated and considered “healthy.”

Successional Stage—Sediment profile data can be used to estimate successional stage of the fauna in a habitat (Rhoads and Germano 1986). Characteristics that are associated with pioneering or colonizing (Stage I) assemblages (in the sense of Odum, 1969), such as dense aggregations of small polychaete tubes at the surface and shallow apparent RPD layers, may be readily visible in sediment-profile images. Advanced or equilibrium (Stage III) assemblages also have characteristics that can be seen in profile images, such as deep apparent RPD layers and subsurface feeding voids. Stage II is intermediate between Stages I and III and has characteristics of both (Rhoads and Germano 1986).

Organism Sediment Index (OSI)—Sediment Profile Imagery image data can be combined to summarize environmental conditions. The OSI, as developed by Rhoads and Germano (1986), is an integrative estimate of the general “health” of the benthic habitat for supporting fauna. Rhoads and Germano (1986) developed this index to provide a measure of relative habitat quality for living resources. Their organism sediment index (OSI) is defined from both Sediment Profile Imagery parameters and measurements of

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 142 of 174
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dissolved oxygen on the bottom. The lowest value of the OSI (–10) is given to habitats that have little or no dissolved oxygen, no apparent evidence of fauna (surface or subsurface data), and methane gas present (subsurface data). The highest value of the OSI (+11) is given to habitats that have high dissolved oxygen, a deep apparent RPD layer, evidence of fauna, and no methane gas. The index is calculated from RPD depth, successional stage, the presence of methane voids, and visual indications of low oxygen concentrations in the water-column.

3.6.6 Instrument/Equipment Calibration, Maintenance, and Operation

Laboratory instruments and equipment must be tested, maintained, and calibrated according to SOPs and the manufacturers' instructions prior to use. The manufacturer manuals and SOPs must be readily available at the bench so that trouble-shooting and routine repairs can be performed correctly. All routine maintenance and non-routine repairs are to be documented in a permanent location (e.g., electronically or in bound logbooks). The return to analytical control is demonstrated by successful calibration. Instruments and equipment that are out-of-calibration must be tagged or removed from the laboratory to prevent inadvertent use. Calibration requirements are defined in Table 3-16.

- Certified calibration standards will be used for instrument calibration. Where possible, standards will be traceable to National Institute of Standards and Technology (NIST).
- Stock solutions for spiking solutions, surrogate compounds, and other organic or inorganic compound mixes will be made from reagent-grade chemicals or as specified in the SOPs. All analytical stock solutions will be prepared using Class-A volumetric ware.
- Preparation of stock solutions must be documented including the parent material used (lot number and concentration), the amount used, the final solution volume, and the final solution concentration. Specific handling and documentation requirements for the use of standards will be defined in laboratory SOPs.
- All new calibration or spiking solutions must be analyzed against a previously accepted standard to verify that the concentrations are acceptable.

Prior to analysis, a calibration curve must be verified through the analysis of a check solution prepared from a source (or at least a lot) independent of that used for the initial calibration curve. The calibration check solutions must include all targeted analytes.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 143 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 144 of 174
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Table 3-16 Calibration Procedures for Laboratory Instruments

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)
Gas Chromatography/ Mass Spectrometry (GC/MS)	Initial Calibration (ICAL) Standard	Prior to samples	≤25% relative standard deviation (RSD) for each analyte and average RSD for all analytes ≤ 15%, R≤0.995	Reanalyze, if failure repeats, take remedial action, if failure continues, a new ICAL is performed
	Independent Calibration Check (ICC)	After ICAL or if failure of continuing calibration verification (CCV)	PD must be ≤ 25% for each analyte and internal standard (IS) area has not changed by more than a factor of two from the area in level 3 ICAL	Evaluate and re-analyze, if this ICC fails, perform remedial action and reanalyze. If a second ICC fails, a new ICAL is performed or justify results.
	CCV	Beginning and end of 10 injections, or 24 hr period	≤25% from true check std. conc. for each analyte and average difference for all analytes ≤ 15%, and IS area has not changed by more than a factor of two from the area in level 3 ICAL	Re-injection of samples prior to a CCV may be warranted. Evaluate samples, sample extracts must be bracketed by an acceptable CCV
GC-Flame Ionization Detection (FID)	ICAL Standard	Prior to samples	≤25% relative standard deviation (RSD) for each analyte and average RSD for all analytes ≤ 20%, R≤0.995	Evaluate, re-analyze if necessary, discuss with PM
	ICC	After ICAL	RSD must be ≤ 25% for each analyte and ≤ 25% for the mean, the IS area must be within a factor of 2 from the Level 3 ICAL and mass discrimination must be ≥0.8	Reanalyze, if failure repeats, take remedial action, if failure continues, a new ICAL is performed
	CCV	After every 10 injections, or 24 hr	≤25% from true check standard conc. for each analyte and average difference for all analytes ≤ 20%	Reanalyze, if failure repeats, take remedial action, if failure continues, a new ICAL is performed. Samples must be bracketed by an acceptable CCV
Purge and Trap GC/MS	ICAL Standard	Prior to samples	≤30% RSD for each analyte and average RSD for all analytes ≤ 15%, R≤0.995	Recalibrate if >10% of target analytes exceed %RSD or R ² criteria If ≤ 10% of target compounds exceed criteria, recalibration is not required provided %RSD is < 40% or R ² >0.98. If failure repeats, take remedial action, if failure continues, a new ICAL is performed

**AKG-28-8100– Noble Discoverer
Revision 0, Effective Date May 2013**

Page 145 of 174

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*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)
	ICC	After ICAL	PD must be $\leq 30\%$ for most analytes (40-60% for oxygenates) and the IS area must be within a factor of 2 from the Level 3 ICAL	Recalibrate if $>10\%$ of target analytes exceed criteria. Reanalyze, perform remedial action as necessary, reanalyze if second ICC fails, a new ICAL is performed
	CCV	beginning and end of each 12 h period	$\leq 30\%$ PD for each analyte, average difference for all analytes $\leq 15\%$ and the IS area must be within a factor of 2 from the Level 3 ICAL	Reanalyze if $>10\%$ of target analytes exceed criteria. If $\leq 10\%$ of target compounds exceed criteria, affected sample re-analysis is not required if the % difference for exceeding analytes is $< 40\%$ (or 60% for oxygenates) Evaluate and re-analysis of samples analyzed after failed CCV, if necessary. Samples must be bracketed by an acceptable CCV
CVAAS	5 point curve	Before, during, and after analysis of 20 samples	$R^2 > 0.995$	Recalibrate
Total Hg cold vapor atomic fluorescence spectrophotometer (CVAFS)	4 point curve	Daily	$R^2 > 0.995$	Recalibrate
Methylmercury CVAF	5 point curve using two standards	Daily	$R^2 > 0.995$	Recalibrate
ICP-MS	3-5 point curve depending on metal; $r \geq 0.999$ for all metals	Recheck standards every 8-10 samples	Continuing calibration with %RSD $< 15\%$	Rerun samples
FAAS	3-5 point curve depending on metal; $r \geq 0.999$ for all metals	Recheck standards every 8-10 samples	Continuing calibration with %RSD $< 15\%$	Rerun samples
Total Carbon Analyzer	4 pt curve, $r \geq 0.999$	Recheck standards every 8-10 samples	Continuing calibration %RSD $< 15\%$	Rerun samples

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013		Page 146 of 174
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3.7 Quality Assurance/Quality Control

The project QAM is independent of all work activities. Personnel performing QA activities within each organization must be trained and independent of the technical work they are reviewing. QA staff will monitor the technical components of the project according to organizational SOPs to ensure the accuracy, integrity, and completeness of the data. Analytical staff members will be responsible for ensuring that sample tracking, sample preparation, and analytical instrument operation all meet the quality-control criteria detailed in the applicable analytical SOPs.

The project design incorporates SOPs to ensure consistency (Table 3-17) and QC procedures and checks in both the field and laboratory in order to assess data quality. The study design and QC samples are intended to assess the major components of total study error, which facilitates the final evaluation of whether environmental data are of sufficient quality to support the related decisions. The QC sample requirements are designed to provide information on measurement error that can be used to initiate corrective actions with the goal of limiting the total measurement error.

Table 3-17 Standard Operating Procedures

SOP Number	SOP Title
Field	
SOP-01	Field Documentation
SOP-02	Sample Custody
SOP-03	Sample Packaging and Shipping
SOP-04	Decontamination of Equipment – Sediments
SOP-05	Preparation of Field Quality Control Samples
SOP-06	Surface Sediment Sampling Using a Modified van Veen Grab Sampler
SOP-07	Decontamination of Sampling Equipment
SOP-08	Preparation of Field Quality Control Samples – Tissues
SOP-12	Benthic tissue sampling for chemical analysis using a dredge/rake
SOP-13	Amphipod sampling for chemical analysis using a modified minnow trap
SAM044.01	Sediment Profile Imaging and Plan View Photography Collection
SOP 5-275	At-Sea Collection of Hydrographic Data Using CTD and Rosette System
SOP 5-342	Collecting Sediment Cores with a Piston Push/Hammer Corer
SAM043.01	Benthic Sample Collection and Processing
Grain Size	Folk, 1974 (sieve and pipette)
2001	Chain of Custody Procedures
2004	Decontamination of Procedures
2007	Sample Collection for Chromium VI, Silver, and Thallium in Water-Based Drilling Fluid
2008	Sample Collection for TAH and TAqH Analyses
2009	Sample Collection for Mercury and Cadmium in Stock Barite
2014	Sample Collection for TSS Analysis

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 147 of 174
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SOP Number	SOP Title
Laboratory	
5-157	Identification and Quantification of Semi-Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry
5-190	Tissue Extraction for Trace Level Semi-Volatile Organic Contaminant Analysis
5-191	Size Exclusion high performance liquid chromatography (HPLC) Cleanup of Sample Extracts for Semi-Volatile Organic Pollutants
5-192	Soil/Sediment Extraction Using an Orbital Shaker Table Method for Trace Level Semi-Volatile Organic Contaminant Analysis
5-200	Water Extraction for Trace Level Semi-Volatile Organic Contaminant Analysis
5-202	Determination of Low Level Total Petroleum Hydrocarbons and Individual Hydrocarbon Concentrations in Environmental Samples
5-245	Preparation and Analysis of Volatile Hydrocarbons in Environmental Samples
5-328	Removal of Sulfur from Environmental Sample Extracts
5-330	Silica Gel Fractionation of Environmental Extracts for the Separation of Saturated Hydrocarbons and Aromatic Compounds
5-329	Alumina Clean-up of Environmental Sample Extracts
6-010	Sample Receipt, Custody, and Handling
FIT-0004 Series	Determination of (Metal) in Seawater Following Preconcentration by Reductive Precipitation
FIT-0006	Total Mercury in Aqueous Samples by Cold Vapor Atomic Fluorescence (CVAf)
FIT-1012 Series	Determination of (Metal) in Tissues ICP-MS
FIT-1013 Series	Determination of (Metal) in Tissues by FAAS
FIT-1014	Determination of Mercury in Tissues by Cold Vapor Atomic Absorption Spectrometry (CVAAS)
FIT-2010 Series	Determination of (Metal) in Sediments by FAAS
FIT-2012 Series	Determination of (Metal) in Sediments by ICP-MS
FIT-2014	Determination of Mercury in Sediments by Cold Vapor Atomic Absorption Spectrometry (CVAAS)
FIT 2015	TOC
FIT-6003	Determination of Particulate (Metal) by FAAS
FIT-6005	Determination of Particulate (Metal) by ICP-MS
Folk, 1974	Grain Size by sieve and pipette
MSL-I-014	Methylmercury in Aqueous Samples by Cold Vapor Atomic Fluorescence (CVAf)
MSL-I-015	Methylmercury in Tissues and Sediments by Cold Vapor Atomic Fluorescence (CVAf)
SAM043.01	Benthic Sample Collection and Processing

3.7.1 Field Quality Control

Field QC samples will be collected in the same type of sample containers and in all other ways handled in the same manner as other field samples. The field QC samples will be assigned unique sample numbers and will be submitted to the analytical laboratory as routine samples. If abnormalities are detected in field QC samples, the data associated with the QC samples will be assessed to determine if project data are affected. FWS SOP-05 *Preparation of Field Quality Control Samples* and FWS SOP-08 *Preparation of Field Quality Control Samples – Tissue* describe specific procedures for preparing field QC samples.

The following field QC samples will be collected as defined in Section 1.9.1.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 148 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

- Trip blanks will be prepared and submitted for analysis at the frequency of one per shipping container of VOC samples.
- Temperature blanks will accompany each cooler that contains samples with a temperature preservative requirement. The temperature blank will be created either in the field or laboratory by filling polyethylene bottles with deionized water or sediment, depending on the matrix being shipped.
- MS/MSD samples will be collected at a frequency of 5% of the field samples (i.e., 1/20 samples) for sediment, water, and tissue samples.
- Field duplicates will be collected as separate co-located sample and will be analyzed for the same chemical and physical parameters as the other samples from its location. At a minimum, field duplicates are collected for 5% each of the sediment, water, and tissue samples.

Field QC samples that will be collected specific to the EMP are described in the following sections.

3.7.1.1 Equipment (Rinsate) Blank (EB)

An equipment blank is a sample of contaminant-free medium (typically reagent-grade water) that has been passed through or over the sampling equipment used to collect field samples. An equipment blank is collected in the same type of sample containers and in all other ways is handled in the same manner as other field samples. The equipment blank must be collected during the sampling event, after collection of at least one field sample, after normal equipment decontamination procedures, and prior to collection of the next field sample. Sampling devices for sediment include the grab, stainless steel spoons or spatulas, bowls, and flexible tubing. EB will be collected at a frequency of one per sampling device per day for sediment and water samples.

3.7.1.2 Field Blanks

A sample of analyte free water poured into the container in the field, preserved and shipped to the laboratory with field samples. Purpose: Assess contamination from field conditions during sampling. Field blanks are prepared at a frequency of one per day per matrix or one per 20 samples per matrix, whichever is more frequent.

3.7.1.3 Laboratory Duplicates (Laboratory Splits)

Laboratory duplicates (also called laboratory splits) are used to assess the precision of the analytical method and laboratory handling. For the laboratory duplicate analysis one sample will be split by the analytical laboratory into two portions and each analyzed. When collecting samples to be analyzed for laboratory duplicates, typically double the normal sample volume is required. This requires filling a larger size sample bottle, or filling two normal size sample bottles, labeling one with the site name and the second with the site name plus "laboratory duplicate". Laboratory duplicate samples are collected, handled, and delivered to the analytical laboratory in the same manner as environmental samples.

3.7.1.4 Field-Spiked Holding Time Samples

A field-spiked sample will be prepared each day that water samples are collected to track sample integrity in case the 14-day holding time cannot be met. A solution of PAH/SHC/biomarker standards will be prepared and sealed in ampoules in the laboratory prior to the survey. The spike solution will be the same

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 149 of 174
CAUTION: All hardcopies of "Controlling Document" are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

at that used in the laboratory to spike the laboratory control sample (LCS) and MS/MSD samples. The spike solution will be added to 1-L site water samples, assigned a unique identification number, and stored with the water samples. If analysis shows that the concentrations are within acceptable error limits of spiked samples then the field sample integrity will be confirmed. If the concentrations are lower than acceptable error limits, the lower recoveries will be used to assess the relative degradation of the sample compounds.

3.7.1.5 Benthic Samples

For benthic samples, every effort will be made to use only grabs that have demonstrated no wash-out of the sediment surface. Except under extenuating circumstances, van Veen grabs should be full, so low-volume grabs should be rejected for community-composition samples. Samples will be carefully dropped into buckets and transported and poured into the sieves without spillage. A substantial spillage will require a new sample. Samples will be rinsed over a nested 1.0-mm-mesh and 0.5-mm-mesh screens with a water pressure strong enough to remove sediments but weak enough to minimize damage to the animals. Biological and sediment residues will be carefully removed from each sieve, so that all visible animals, sediment particles, and fragments will be removed. Samples then will be placed into jars labeled with the date of collection, station name, replicate number, sieve mesh size, and initials of personnel packaging the samples. Pertinent information also will be recorded on sample-collection sheets that list the collection date, station name, water depth, and gross sediment characteristics. This information will also be included on a waterproof sample tag that is placed inside the specimen jar or container. The pertinent information then will be entered into the shipboard database for managing workflow and data collections and will be checked daily for accuracy.

3.7.1.6 Accuracy and Precision of the ADCP and CTD Sensor Arrays

Table 3-18 defines typical accuracy and precision of ADCP instrument sensors. Table 3-19 defines typical accuracy and precision of the CTD instrument sensors. The accuracy and precision of the equipment deployed during the environmental monitoring will similar to these values and will be documented and reported with the data.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 150 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Table 3-18 Typical Accuracy and Precision of Instrument Sensors (ADCP and OBS)

Sensor	Model (or equivalent)	Measurement	Units	Range	Accuracy	Precision
ADCP	Teledyne RDI Workhorse Sentinel 300khz	Current velocity	cm/s	0 to 500	1	0.1
		Depth	M	0 to 40	2%	1 cm
		Waves	cm, sec	> 0 cm > 3.3 sec	1%, 1%	1cm, 0.5 sec
OBS	Seapoint Sensors Turbidity Meter	Turbidity	NTU	0 to 25	Calibration Dependent	2%

Table 3-19 Typical Accuracy and Precision of Instrument Sensors (CTD)

Sensor	Model/Method (or equivalent)	Units	Range	Accuracy	Resolution
Pressure	Sea-Bird SBE 19plus V2	Decibars	0 to 1000	0.1% of range	0.002% of range
Temperature	Sea-Bird SBE 19plus V2	°C	-5 to +35	0.005	0.0001
Conductivity	Sea-Bird SBE 19plus V2	mS/cm	0 to 9000	0.5	0.05
Transmissometer (25-cm)	WET Labs C-Star 25cm	m ⁻¹	0 to 40	0.20	0.01
OBS	Seapoint Sensors Turbidity Meter	NTU	0 to 25	Calibration Dependent	0.01
			0 to 125	5%	2%
			0 to 500	5%	2%
ADCP	Teledyne RDI Workhorse Sentinel 300khz	Current velocity (cm/s)	165m	4.2 cm/s Std Dev	2- 8 m
		Echo Intensity Profile (decibels)	0 to 80	1%	±1.5dB
		Depth(m)	0 to 165	2%	0.5m (bin size)

3.7.2 Laboratory Quality Control

Quality control is an integral part of the laboratory activities. It lays out methods for maximizing the quality of operations and analyses, provides analysts with metrics about method performance, and aids project managers in identifying and correcting systematic and random problems that can plague the laboratory operations.

Laboratory samples will be processed and analyzed in analytical batches or sample delivery groups (SDGs) of ≤20 field samples plus laboratory QC. A suite of QC samples that monitors the accuracy and precision of the methods will be incorporated into each batch; these samples are defined below. In addition to these QC samples, surrogate internal standards will be spiked into each sample analyzed for organic compounds. The acceptance criteria and corrective action for each QA sample is defined in Table 3-20.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 151 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Table 3-20 Measurement Quality Criteria

QC Sample Type	Data Quality Objective	Corrective Action
Equipment Blank (EB) Field Blank (FB)	No target analyte concentrations $\geq 5x$ the MDLs if sample concentrations are $<10x$ the MDL	Review results vs sample data. Report data with qualifiers if sample concentration is $< 5X$ the EB or FB.
Field Duplicate (DU)	No criteria defined. Results will be used to assess sample heterogeneity or inconsistent sample handling and analysis procedures	
VOC (water/drill mud/ cuttings)		
Method Blank (MB)	Results are less than $5x$ the MDL Samples must be greater than $5x$ the MB	Review with the PM, re-analyze or justify results
Laboratory Control Sample (LCS)	Spiked target analytes must be recovered at 70-130%	Review with the PM, re-analyze or justify results
Laboratory Duplicates (QADU)	≤ 30 RPD	Review with PM, restrict and reanalyze. If data continues to fail, report data with qualifiers.
Matrix Spike (MS)	Spiked target analytes must be recovered at 70-130%	Compare with LCS results. If the MS results are outside the LCS, review with the PM to determine if the difference is attributed to matrix effect or analytical error. Review all sample prep records, re-analyze as directed by the PM.
Hydrocarbons (PAH/SHC/TPH/Biomarker)		
MB	Results are less than $5x$ the MDL. Samples must be greater than $5x$ MB	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
LCS	Spiked target analytes must be recovered at 70-130%	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
QADU	Less than or equal to 30% RPD	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
MS	Spiked target analytes must be recovered at 70-130%	Compare with LCS results. If the MS results are outside the LCS, review with the PM to determine if the difference is attributed to matrix effect or analytical error. Review all sample prep records, re-analyze as directed by the PM.
Matrix Spike Duplicates (MSD)	≤ 30 RPD	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
North Slope Crude (NSC)	≤ 30 RPD	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
Standard Reference Material (SRM) Certified Reference Material (CRM)	≤ 30 PD from target concentration plus the 95% confidence level analyte concentration must be $> 5x$ sample specific MDL	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
Metals		
EB	No target analyte concentrations $\geq 5x$ the MDLs if sample concentrations are $<10x$ the	Review results vs sample data. Report data with qualifiers if sample concentration is $<$

**AKG-28-8100– Noble Discoverer
Revision 0, Effective Date May 2013**

Page 152 of 174

CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.

*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

QC Sample Type	Data Quality Objective	Corrective Action
FB	MDL	5X the EB or BF.
MB	All analytes in the method blank must be less than ½ the RL	Re-prepare and reanalyze the method blank and all samples processed with the contaminated blank. If problem persists, call PM.
LCS	Recovery: Concentration within 20% of certified value.	Correct problem, re-prepare and reanalyze LCS and all samples in associated batch for failed analytes. If problem persists, call PM.
LCS Duplicates (LCSD)	RPD<10% at 10x detection limit	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
MS	Spiked target analytes must be recovered at 85 – 115%	Compare with LCS results. If the MS results are outside the LCS, review with the PM to determine if the difference is attributed to matrix effect or analytical error. Review all sample prep records, re-analyze as directed by the PM.
MSD	Water & Sediment: RPD: ±10% Tissue: RPD 100 ± 15%	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
Completeness	The goal for completeness is ≥90%	
Mercury		
MB	<5x the MDL	Reanalyze. If confirmed and all samples are >10x the blank, no corrective action is required. If samples are <10x the blank, the batch must be re-prepped and re-analyzed.
SRM	Tissue & Sediment: 80-120% of certified value	Sediment & Tissue: Reanalyze. Failure to meet criteria shall be reported in Data Summary. Failure of multiple DQOs requires re-preparation and reanalysis of batch.
MS	80-120% recovery	Reanalyze. Failure to meet criteria shall be reported in Data Summary. Failure of multiple DQOs requires re-preparation and reanalysis of batch.
MSD	RPD ≤ 20%	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
Sensitivity	Low Level Check Sample run at the MRL Recovery: 80-120%	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
Methylmercury		
MB	<5x the MDL	Reanalyze. If confirmed and all samples are > 10x the blank, no corrective action is required. If samples are <10x the blank, the batch must be re-prepped and re-analyzed.
LCS	67 – 133% of certified value	Correct problem, re-prepare and reanalyze LCS and all samples in associated batch for failed analytes. If problem persists, call PM.
LCSD	RPD≤ 35% when methylmercury is detected in both samples ≥ 5x the sample-specific MDL	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
SRM	67-133% of certified values	Reanalyze. Failure to meet criteria shall be

**AKG-28-8100– Noble Discoverer
Revision 0, Effective Date May 2013**

Page 153 of 174

CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.

*Quality Assurance Project Plan
For Exploration Drilling in Alaska
OCS, Chukchi Sea, M/V Noble Discoverer*

QC Sample Type	Data Quality Objective	Corrective Action
		reported in Data Summary. Failure of multiple CRMs/OPRs requires redigestion and reanalysis of batch. (OPR is performed at the beginning of sequence and end of sequence)
MS	Sediment & Tissue: Recovery 60-135%; Water: Recovery 65-135%	Reanalyze. Failure to meet criteria shall be reported in Data Summary. Failure of multiple MSs requires re-preparation and reanalysis of batch.
MSD	RPD \leq 35%	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
Sensitivity	OPR Sample spiked at 10x the MRL	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
TOC (Sediment)		
MB	All analytes in the method blank must be less than $\frac{1}{2}$ the RL	Re-prepare and reanalyze the method blank and all samples processed with the contaminated blank. If problem persists, call PM.
LCS	80 – 120% of certified value	Correct Problem, re-prepare and reanalyze LCS and all samples in associated batch for failed analytes. If problem persists, call PM.
QADU	RPD <10% at 10x detection limit	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
SRM	\pm 15% of certified value	Reanalyze. Failure to meet criteria shall be reported in Data Summary. Failure of multiple CRMs requires redigestion and reanalysis of batch.
Completeness	>90%	Report results and assess impact
POC (Water Particulates)		
MB	All analytes in the method blank must be less than $\frac{1}{2}$ the RL	Re-prepare and reanalyze the method blank and all samples processed with the contaminated blank. If problem persists, call PM.
LCS	80 – 120% of certified value	Correct Problem, Re-prepare and reanalyze LCS and all samples in associated batch for failed analytes. If problem persists, call PM.
LCSD	RPB<10%	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
SRM	\pm 15% of certified number	Reanalyze. Failure to meet criteria shall be reported in Data Summary. Failure of multiple CRMs requires redigestion and reanalysis of batch.
Completeness	>90%	Report results and assess impact
TSS (Water)		
MB	No target analyte concentrations \geq RL or \geq 10% of the measured values of the samples (whichever is larger)	Re-prepare and reanalyze the method blank and all samples processed with the contaminated blank. If problem persists, call PM.

AKG-28-8100– Noble Discoverer
Revision 0, Effective Date May 2013

Page 154 of 174

CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.

QC Sample Type	Data Quality Objective	Corrective Action
LCS SRM	Analyte must have recoveries of 90-100% or be within the manufacturer's control limits if they are great than the 90-100% range	Correct problem, re-prepare and reanalyze LCS and all samples in associated batch for failed analytes. If problem persists, call PM.
LCSD	RPD \leq 20% when sulfur is detected in both samples \geq sample-specific MRL times 10	Review with PM, re-extract and reanalyze. If data continues to fail, report data with qualifiers.
Completeness	\geq 90%	
Grain Size (Sediment)		
Laboratory Duplicate	RDP < 20% of any individual values for gravel, sand, silt, or clay	Correct problem by re-homogenizing sediment to provide a more representative sample and repeat analysis.
Completeness	>90%	Assess impact and take corrective action.
Sediment Profile Imagery		
Independent Check	Measurements \pm 1.0 cm and Counts \pm 2 counts Pixel density (adequate focus, exposure, and detail)	Reanalyze all images for parameters out of QC range
Benthic Organisms (Sediment)		
Laboratory report	>90% for Overall precision, analytical precision, analytical Accuracy/Bias	Correct problem, resort, reweigh all samples in batch
Taxonomy	100% of junior taxonomist samples verified. Questionable organisms of senior taxonomists verified	Discuss identifications with taxonomists.

Notes:

¹ Table represents criteria for all matrices unless otherwise noted.

² Mercury and Methylmercury water analysis is on Total and Dissolved Water

The following laboratory QC samples will be analyzed as defined in Section 1.9.2.

- Method blank for each preparatory and analytical batch.
- LCS (prepared using contaminant-free matrix-specific sample, e.g., Ottawa sand or sodium sulfate [sediment] and clean Tilapia [tissue]).
- MS/MSD samples, prepared from the same parent sample and spiked with the analytes of interest at approximately 10X the MDL.
- A laboratory duplicate (QADU) is a second aliquot of a field sample processed and analyzed to monitor precision. It may be a second matrix-spike sample.

Additional laboratory QC specific to the EMP are described in the following sections.

3.7.3 Standard Reference Material

An SRM is characterized by a metrologically valid procedure for one or more specified properties, accompanied by a certificate that provides the value of the specified property, its associated uncertainty, and a statement of metrological traceability. A SRM is prepared with each processing batch to assess accuracy of the analytical procedures.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 155 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

3.7.3.1 North Slope Crude Reference Oil

A NSC Reference Oil sample is used to evaluate the instrumental accuracy and also provide petroleum pattern information, aiding in the qualitative identification of target analytes. The NSC is analyzed for organics only.

The MQO for each QC sample in this project are presented in Table 3-20. Analytical results that do not meet the MQOs will be submitted to and/or reviewed with the Project Manager for assessment of the potential impact of the results. Affected samples may be reanalyzed at the Project Manager's discretion. QC sample data that are accepted outside the MQOs qualified, and the rationale for accepting the analysis will be documented.

3.7.3.2 Samples for Biological Community Analysis

A small subset of samples employed for community analysis will be reprocessed by a different technician or multiple technicians, when appropriate. Where questions arise, specimens should be compared with the authoritative voucher sets, sent to an appropriate taxonomic expert. Quality-control methods for benthic taxonomic analysis will follow guidelines adapted from the US EPA's Environmental Monitoring and Assessment Program (www.epa.gov/emap/html/pubs/docs/groupdocs/estuary/field/labman.html).

3.8 Nondirect Measurements

A substantial amount of data already exist for the outer continental shelf (OCS) Chukchi Sea as a result of extensive, multidisciplinary research programs (both industry and government) conducted over the past five years. These data are presented in the EMP (OF 2013) and will be used as part of the Phase I baseline characterization. Hence, baseline-characterization data already exist from empirical data collected in the past 5 years.

3.9 Data Management

During this study, both hard copy and electronic data records will be generated in the field by several principle investigators from different organizations. Each PI is responsible for ensuring that records generated by their field staff follow the requirements of this QAPP. Similarly, field samples will be analyzed in several fixed laboratories for a variety of parameters; the laboratory manager is responsible for ensuring that data management procedures are consistent with this QAPP. All the organizations that collect data in support of the EMP will maintain the original records that support their findings, report detailed results and provide copies of their records to OF at the end of each reporting phase.

3.9.1 Document Control

The QAPP and associated SOPs are controlled documents. The following procedures will be implemented to ensure that project personnel have the current versions of these documents.

- The document version number and effective date is defined in the header control block.
- Each organization will maintain a master list of current SOPs, which are approved by management and assigned an effective date.
- A distribution list is maintained for this QAPP and associated SOPs.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 156 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

- SOPs that describe environmental data collection activities must be reviewed prior to use to ensure they are current and updated as needed.

Field and laboratory logbooks must be bound, dated, paginated and distinctly labeled.

3.9.1.1 Field Documentation

Field records must provide a detailed description of sample collection activities to ensure that samples and data are traceable and defensible. FWS SOP-01 *Field Documentation* describes these procedures. Field observations will be documented in real time in bound field logbooks and will provide a record of field activities, observations, and measurements during sampling. All field records and documentation must comply with the documentation requirements defined in this QAPP. Field forms required for this study are provided in Attachment D. The field logbooks will be reviewed and approved independently at the end of each survey day.

3.9.1.2 Laboratory Documentation

Documentation of all laboratory activities is critical for tracking data and evaluating the success of any activity. Laboratory documentation requirements must be defined in a laboratory QA Manual or specific SOPs. At a minimum, the laboratories will maintain the following documentation records:

- Calibration and maintenance of all instruments and equipment involved in the collection of environmental data
- Preparation of calibration standards, spiking solutions, and dosing solutions such that each unique preparation can be tracked to the original (neat) material
- Lot numbers for all standards, stock solutions, reagents, and solvents
- Sample processing or preparation for testing such that it is traceable to sample receipt records
- Sample analyses and results of analyses
- Rejected data, accompanied by explanations of the failure and the corrective action
- Data reduction formulas such that reported data are traceable to raw data.

3.9.2 Data Storage Requirements

Storage of project data must ensure that the integrity and traceability of data are maintained. In the field, electronic data will be backed up daily to a second media (e.g., separate hard drive, thumb drive, CD), labeled, and stored securely. Field logs must maintain an inventory of the location of electronic files. Each laboratory must have a documented system of daily incremental and at least monthly full data backups, storage and recovery. Electronic data files received from the laboratories will be stored on a networked project folder with incremental daily and full monthly backups. Storage locations must be appropriate for the media (paper or electronic) and limit access or availability of the data. Once the study is complete, original field records and copies of laboratory records will be submitted to Shell. All hardcopy and electronic project files will be archived by the organization that generated the data for at least 5 years.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 157 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

3.9.3 Documentation Standards

All data generated during the course of this project must be able to withstand challenges to their validity, accuracy, and legibility. To meet this objective, data are recorded in standardized formats and in accordance with prescribed procedures. The documentation of all environmental data collection activities must meet the following minimum requirements:

- Data must be documented directly, promptly, and legibly. All reported data must be uniquely traceable to the raw data. All data reduction formulas must be documented.
- Handwritten data must be recorded in ink. All original data records include, as appropriate, a description of the data collected, units of measurement, unique sample ID and station or location ID (if applicable), name (signature or initials) of the person collecting the data, and date of data collection.
- Any changes to the original (raw data) entry must not obscure the original entry. The change must be initialed and dated by the person making the change.
- The use of pencil, correction fluid, and erasable pen is prohibited.

During the project, records will be maintained in a secure location that minimizes loss as follows:

- Hardcopy records will be maintained in the project files of the principle investigator at each organization. This includes administrative records, field logs, and other field raw data. Field logs and custody forms will also be scanned and saved in pdf format and saved in a networked project folder.
- Electronic records will be maintained on in a networked project folder. No project files may be maintained on personal computers except as temporary working files.
- The results of QA/QC reviews, audits, and assessments will be saved in the QA network folder. Hardcopy audit records will be maintained in the QA files.

3.9.4 Hardware and Software Requirements

The following computer hardware and software standards requirements are established:

- All computer hardware used for this project must use Intel-based Pentium or compatible processors running a Microsoft-compatible operating system so that documents can be transferred between organizations.
- Software used to capture or transfer data electronically from analytical instruments to data management systems must be described in QA documentation, and validated prior to use.
- Data tracking from raw output to final values must be maintained. Data access and change control must be defined, limited, and traceable.
- Calculations performed by analytical instruments, data management software, and spreadsheets must be verified.
- All data and derived products will be stored in the laboratory computers and backed up on CDs.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 158 of 174
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3.9.5 Changes and Deviations

During the conduct of this study, it may be necessary to modify the planned activities. Modifications that are anticipated prior to field or laboratory work will be reported to the project manager, who will assess the potential impact and contact the client if the changes are major (e.g., those that would affect the study objectives, design, or data quality). All modifications will be described in the final report.

Changes that are not anticipated prior to the planned activities are deviations and must be communicated and documented. Documentation will include an assessment of any impact that the deviation has on the study design and data quality, and any corrective action implemented. Minor deviations (e.g., those that would not impact the study objectives, design, or data quality) will be reported to and approved by the appropriate principle investigator and the project manager. Major deviations (e.g., those that could impact the study objectives, design, or data quality) will be reported to the project manager, client, and the Project QAM. A discussion of major deviations and potential impact on the project objectives will be included in the final report.

3.9.6 Data Reporting

The reporting requirements for this project are defined by the analytical methods and intended use of the data.

Field measurements will be reported as follows:

- Water and sediment depth: feet
- Station location: WGS84 latitude and longitude (may change in field, system and units are always recorded with coordinates)

The concentrations of chemical compounds analyzed for this project will be reported in the units defined in Tables 3-10 through 3-15. Sediment concentrations will be reported on a dry weight basis and tissue concentrations will be reported on a wet weight basis. Additional data reporting requirements are as follows:

- Total PAHs: the sum of the 16 PAH priority pollutant PAHs
- Total TPH (C9 – C40)
- Total SHC (C9 – C40)
- TAH: Method 602 volatiles + _o, m, p-xylene
- TAqH: TAH+PAH
- Analytes detected at concentrations greater than the MDL but lower than the laboratory method reporting (quantitation) limit will be reported with a “J” qualifier; values detected below the MDL will be reported as the MDL with a “U” qualifier.
- Non-detect values in sums: Sums will include all detected compounds plus all non-detected compounds using ½ of the individual sample MDL reported for each non-detected compound.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 159 of 174
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3.9.7 Data Reduction

Data reduction is the process of converting raw numbers (*e.g.*, numbers of organisms per replicate) into data that can be displayed graphically, summarized in Tables, or compared statistically for differences between mean values for sampling times or stations. The data discussed in this section are those data that require some manipulation before being submitted to the data management consultant for entry into the database.

3.9.7.1 Infaunal Analysis

There is no manipulation of infaunal data prior to the submission of the infaunal data reports. Statistical analyses are described in Section 3.6.4.

3.9.7.2 Organics and Metals

GC/MS and GC/FID data will be acquired on Hewlett-Packard PC-based Chemstation® minicomputers with dedicated chromatography software and reduced using MS Enviroquant® software. All GC/MS and GC/FID data files will be transferred electronically to a PC so that the data can be incorporated into an electronic database or spreadsheets for final quantification and tabular results presentation. Data for metals analysis by CVAf, CVAAS, ICP-MS, FAAS, and ZGFAAS are collected and processed by the instruments' software systems. Processed data are electronically transferred to Excel™ spreadsheet format for EDD generation. The final reduction of analytical chemistry data will account for the size of the processed sample and dilution factors.

3.9.7.3 Total Organic Carbon

Total organic carbon measurements are acquired on instrument software and downloaded onto Excel™ spreadsheets for final quantification and tabular results presentation. TOC results will be reported as percent total organic carbon on a dry weight basis.

3.9.7.4 Grain Size

Grain Size will be reported as percent of the total for each size fraction measured. Silt content is determined by subtracting the total clay content from the mud content. Data are entered onto a spreadsheet for calculation of silt content. In addition to weight percent by size class, the Gravel: Sand: Silt: Clay ratio and a numerical approximation of mean size and sorting (standard deviation) are calculated.

3.9.7.5 Sediment Profile Imagery Analysis

After visual and computer image analyses are completed, a standard set of parameters (Table 3-15) taken from both analyses is combined and tabulated for reporting. If appropriate, statistical analyses can be done to test hypotheses by applying appropriate parametric (*e.g.*, *t*-test, ANOVA) and/or nonparametric techniques.

Sediment Profile Imagery data are used to summarize environmental conditions through the calculation of the OSI. The OSI, as developed by Rhoads and Germano (1986), is an integrative estimate of the general ability of the benthic habitat to support fauna. The OSI is defined from Sediment Profile Imagery parameters and the indirect estimation of bottom dissolved oxygen levels. The lowest value of the OSI (-10) is given to habitats that have little or no dissolved oxygen, no apparent evidence of fauna (surface or

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 160 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Liveline®.	

subsurface data), and where methane gas is present (subsurface data). The highest value of the OSI (+11) is given to habitats that have high dissolved oxygen, a deep apparent Sediment Profile Imagery RPD layer, evidence of fauna, and no methane gas. The index is calculated by using the Sediment Profile Imagery RPD depth, the successional stage, the presence of methane voids, and visual indications of low oxygen concentrations in the water column.

3.10 Data Review/Qualification

Data review conducted for this project is designed to ensure that reported data are accurate and traceable. Each organization generating data will perform the following data review:

- All data that are hand-entered from an original source to another location (e.g., from field logs to spreadsheets or from an instrument output to a spreadsheet) will be verified by qualified personnel prior to use in calculations or entry into a database.
 - Manually transcribed data are highly susceptible to errors, which could include transposing numbers in the copying process, mis-associating data (e.g., assigning results to the wrong sample), and creating untraceable data by assumption, interpolation, extrapolation (e.g., adding information such as units, times or dates that are not recorded in the original entry). Hand-entered data must be verified 100%.
 - Electronically-transcribed data errors generally consist of an entire entry or record being copied into the wrong location or not copied over at all, resulting in missing data.
- All manual calculations will be performed by a second staff member to verify that calculations are accurate and appropriate.
- Calculations performed by software will be independently verified at a frequency sufficient to ensure that the formulas are correct, appropriate, and consistent, and that calculations are accurately reported. All modifications to data reduction algorithms will be verified prior to submission of data to the Authority.

Reported data will be independently reviewed by the organization's QA/QC unit to verify that reported data are accurate and traceable. The review will verify that data were generated according to the methods and MQC defined in this QAPP, including review of:

- Sample holding times and preservation requirements vs. the requirements of Table 3-6.
- Initial and continuing calibration methods, frequency and results vs. the requirements of Table 3-16.
- Sample extraction and analysis procedures vs. the requirements of Table 3-9.
- Laboratory QC results vs. the requirements of Table 3-20.

Laboratory data that do not meet the requirements of this QAPP will be re-extracted and/or re-analyzed whenever possible. However, if it is not possible (e.g., sample consumed) or beneficial (sample exceeds holding time) to re-extract or re-analyze then data qualifiers will be added and reported with the data. Laboratory data qualifiers are defined in Table 3-21.

AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 161 of 174
CAUTION: All hardcopies of “Controlling Document” are uncontrolled. When using this document verify that the revision matches the revision in the controlled version found on Livelink®.	

Table 3-21 Analytical Data Qualifiers

Laboratory Qualifiers	
Organic Chemistry Data Qualifiers	
B	Blank contamination: The analyte was detected above the RL in an associated blank. For this study, blank contamination indicates that the analyte was found in both a sample and the associated blank. The “B” will be reported on the result associated with the field samples, not the blank.
D	Dilution run. Initial run outside linear range of instrument.
E	Estimate, result outside linear range of instrument. GC/MS only.
J	Estimated value: the analyte was positively identified but is less than the sample-specific RL.
U	Undetected at the MDL: The associated data value is the MDL, adjusted by any dilution factor used in the analysis (i.e., the sample-specific MDL).
N	MQO not achieved. The quality control result, not the related sample compound, is qualified.
Metals Qualifiers	
J	Estimated value: the analyte was positively identified but is less than the sample-specific RL.
U	Undetected at the MDL: The associated data value is the MDL, adjusted by any dilution factor used in the analysis (i.e., the sample-specific MDL).
D	Dilution run. Initial run outside linear range of instrument.
N	MQO not achieved. The quality control result, not the related sample compound, is qualified.
Methylmercury Chemistry Data Qualifiers	
U	Not detected at or above MDL shown
J	Detected between the MDL and the MRL
NA	Not Applicable
NS	Not spiked

As a final review, the project principle investigator or laboratory manager at each organization will review and make professional judgments about the usability of data generated by that organization based on the field notes, field and laboratory QC results, and environmental reasonableness.

Data reported in tables or deliverables will be audited by, or under the direction, of the Project QA Officer. Errors noted in data audits will be communicated to analysts and project management and corrected data will be verified. No data measurements will be eliminated from the reported data or database and data gaps will not be filled through interpolation, extrapolation, or with other existing data. The loss of samples during shipment or analysis will be documented in the data reports.

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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 163 of 174
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AKG-28-8100– Noble Discoverer Revision 0, Effective Date May 2013	Page 164 of 174
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